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An Evaluation of the Effectiveness of a Research Organization's Mechanism for Transferring Technical Information to Applied End Use

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THESIS

AN EVALUATION OF THE EFFECTIVENESS OF A RESEARCH ORGANIZATION'S MECHANISM FOR TRANSFERRING TECHNICAL INFORMATION TO APPLIED END USE

by

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December 1974

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An organizational mechanism instituted at a research/development center to facilitate the transfer of technological information to field operating units is analyzed in an attempt to measure its effectiveness. The evaluation is based on a model derived to quantify the benefits of the information transferred to end users. In addition, other organizational parameters of the users and suppliers of information is evaluated to determine an optimal configuration to maximize the effectiveness of the transfer mechanism.

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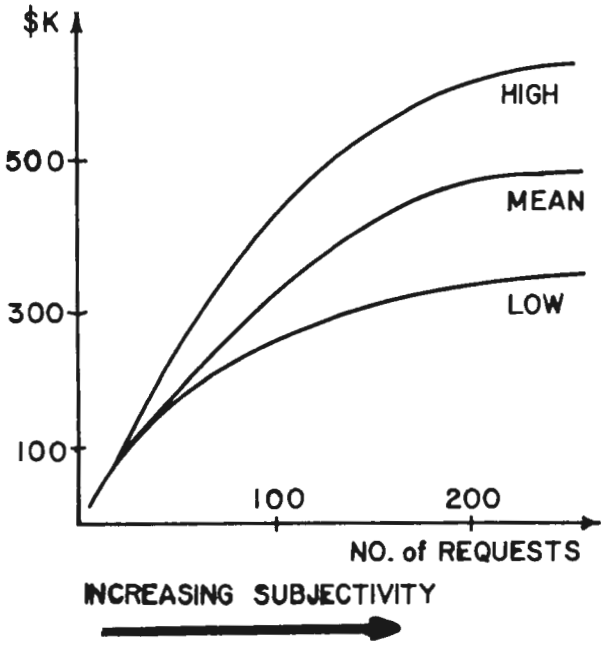
ABSTRACT

An organizational mechanism instituted at a research/development center to facilitate the transfer of technological information to field operating units is analyzed in an attempt to measure its effectiveness. The evaluation is based on a model derived to quantify the benefits of the information transferred to end users. In addition, other organizational parameters of the users and suppliers of information is evaluated to determine an optimal configuration to maximize the effectiveness of the transfer mechanism.

EXECUTIVE SUMMARY

The objective of this thesis is to develop a method of measuring effectiveness of technology transfer mechanisms. The mechanism selected for study was the Facilities Engineering Support Office (FESO) of the Navy's Civil Engineering Laboratory (CEL), which is the major research and development arm of the Naval Facilities Engineering Command (NAVFAC). The primary purpose of FESO is to provide rapid response service on short-term requests for technological assistance from the Navy's shore activities. Results of efforts to measure FESO effectiveness since its formal establishment in 1971 have emphasized the need for a comprehensive method of quantifying the benefits of such a program.

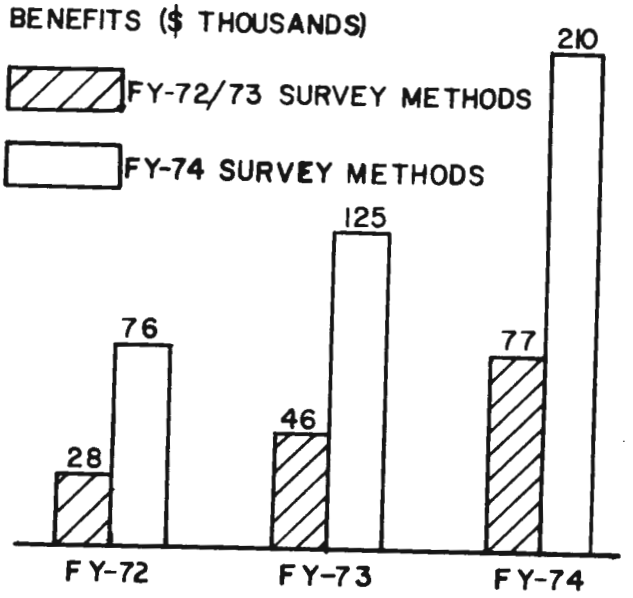
A model is developed that quantifies in dollar terms the benefit of the information provided by CEL to shore activities. By use of the model, approximately 70% of the benefits realized were quantified, whereas previous methods were able to quantify only 20-30%. The results of applying the model to a sample size representing 75% of the



FY '74 FESO requests is displayed in a graph which not only shows the value of the benefits quantified but also shows the inaccuracy introduced by the subjectivity inherent in the quantification of intangible benefits. This inaccuracy is represented by the vertical spread between the high and low curves, which occurs due to the personal value of different estimators or decision-makers.

Using the mean value for benefits, the FY '74 FESO operation was subjected to cost/benefit analysis. The results of this analysis showed that the overall FESO operation was profitable by a benefit-to-cost ratio of over two-to-one.

Growth trends of the FESO program in terms of benefits were compiled and are depicted graphically. The graph shows encouraging increases in the beneficial services provided to field activities.



Benefits derived from the model were correlated against certain FESO system parameters, namely: project type, activity type, originator type and geographical area. Together with survey information revealing the most effective program advertisement methods,

this correlation data suggested guidelines for total system optimization.

Although the model developed is not subject to analytical analysis and proof, the results obtained therefrom have intuitive appeal. The study contains sufficient information about the FESO system such that the particular differences between FESO and any other technology transfer system which an analyst may desire to examine may be identified, and thus, the model may be adjusted as appropriate for such other analysis.

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I. INTRODUCTION

A. TECHNOLOGY TRANSFER

The concept of "technology transfer" is difficult to define since its meaning seems to vary with the audience discussing it. In general, however, the transfer of technology differs from the usual dissemination of scientific knowledge in that it is more concerned with the usage of technological information obtained through research/development effort. Thus, any mechanisms developed for transferring technology from its origin to its usage should be more directed toward suggesting methods and areas of application than toward merely publishing scientific results in technical documents to be filed in technical sections of depositories [Ref. 1].

In the United States the federal laboratory system represents a vast resource of science and technology, with over 469 major research and development (R&D) installations [Ref. 2]. These agencies have been producing technological reports at about 50,000 per year [Ref. 3]. President Richard M. Nixon, during a special message to Congress on science and technology on March 16, 1972, emphasized the need for the federal government to actively disseminate this technology to the public and private sectors in an effort to increase the economic benefit of the information.

At present the federal government is supporting a number of transfer programs in several agencies and departments;

however, it is very difficult to measure their results. In short, there is a need for comprehensive experiments--which would investigate the acquisition, evaluation, and dissemination of technical information and the measurement of its use after dissemination [Ref. 4].

B. OBJECTIVE OF THE STUDY

The objective of this thesis will be to develop a model to measure the effectiveness of a specific mechanism to transfer technology from a federal technological/research organization to operating field units or end users. Specifically, the mechanism under study is the Facilities Engineering Support Office (FESO) of the Navy's Civil Engineering Laboratory (CEL), which was established in 1971 to facilitate the transfer of technological information available within the Laboratory to the Navy's field operating units.

It is the objective of this study to provide a meaningful method of quantifying the benefits of such a transfer mechanism and to demonstrate the usefulness of such measurement in determining the optimal configuration of such a system. The pursuit of this objective begins in Chapter II with a review of NAVFAC's RDT&E program as it relates to CEL and the Navy's shore facilities. Chapter III describes the FESO, its goals, its history and past efforts to measure its effectiveness. Chapter IV establishes the criteria by which effectiveness will be measured and describes the method of gathering data based on this criteria, taking into account the experience gained in past years' efforts. The model used to quantify

benefits is developed in Chapter V and applied to the survey data on the FESO mechanism in Chapter VI. In Chapter VII, the benefits thus quantified are used in a cost/benefit analysis of the program. Chapter VIII utilizes the quantified benefits in an analysis to optimize effectiveness with respect to various system parameters.

II. GENERAL BACKGROUND

A. NAVFAC'S RDT&E PROGRAM

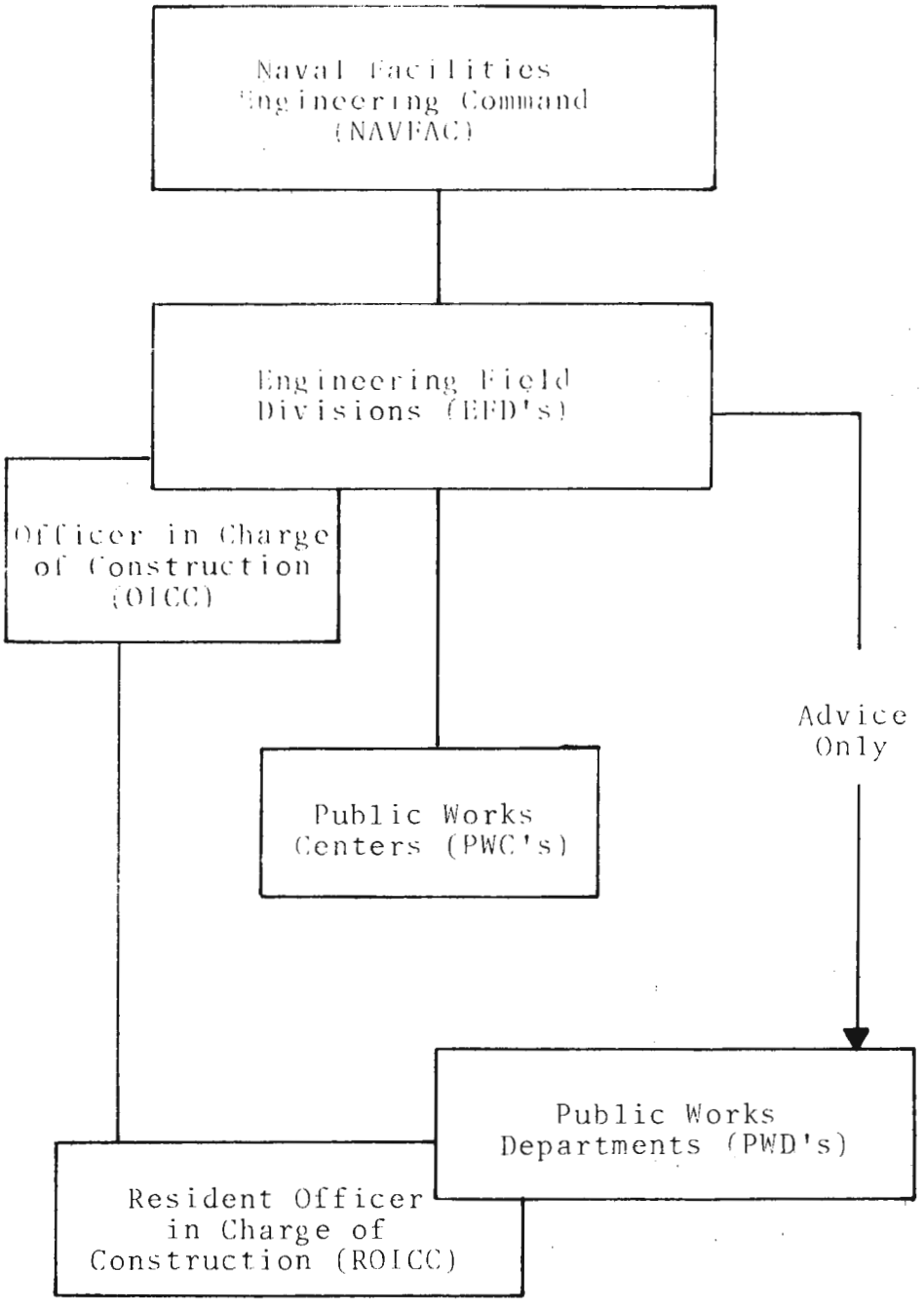
The Naval Facilities Engineering Command (NAVFAC) executes a program of research, development, test and evaluation (RDT&E) for shore facilities, advance base and amphibious operations, sea floor structures, environmental control and those aspects of weapon systems related to its mission. A significant portion of the emphasis of NAVFAC's program is to provide RDT&E which will benefit the Navy's shore facilities in efficiently and effectively meeting their independent missions. NAVFAC's link to the shore facilities is primarily through the Engineering Field Divisions (EFD's), Public Works Centers (PWC's), Public Works Departments (PWD's) and its construction program (OICC/ROICC). Figure II-1 shows these relationships. A major portion of NAVFAC's RDT&E effort is assigned to CEL in the form of specific research projects.

B. CIVIL ENGINEERING LABORATORY

The Civil Engineering Laboratory (CEL) is under the administrative control of the Construction Battalion Center, Port Hueneme, California, and is the principal research, development, test and evaluation center for shore and sea floor facilities and for support of Navy and Marine Corps construction forces [Ref. 5]. The staff of CEL consists of approximately 320 personnel, 150 of whom are professional engineers. The basic organization is shown in Figure II-2.

FIGURE II-1

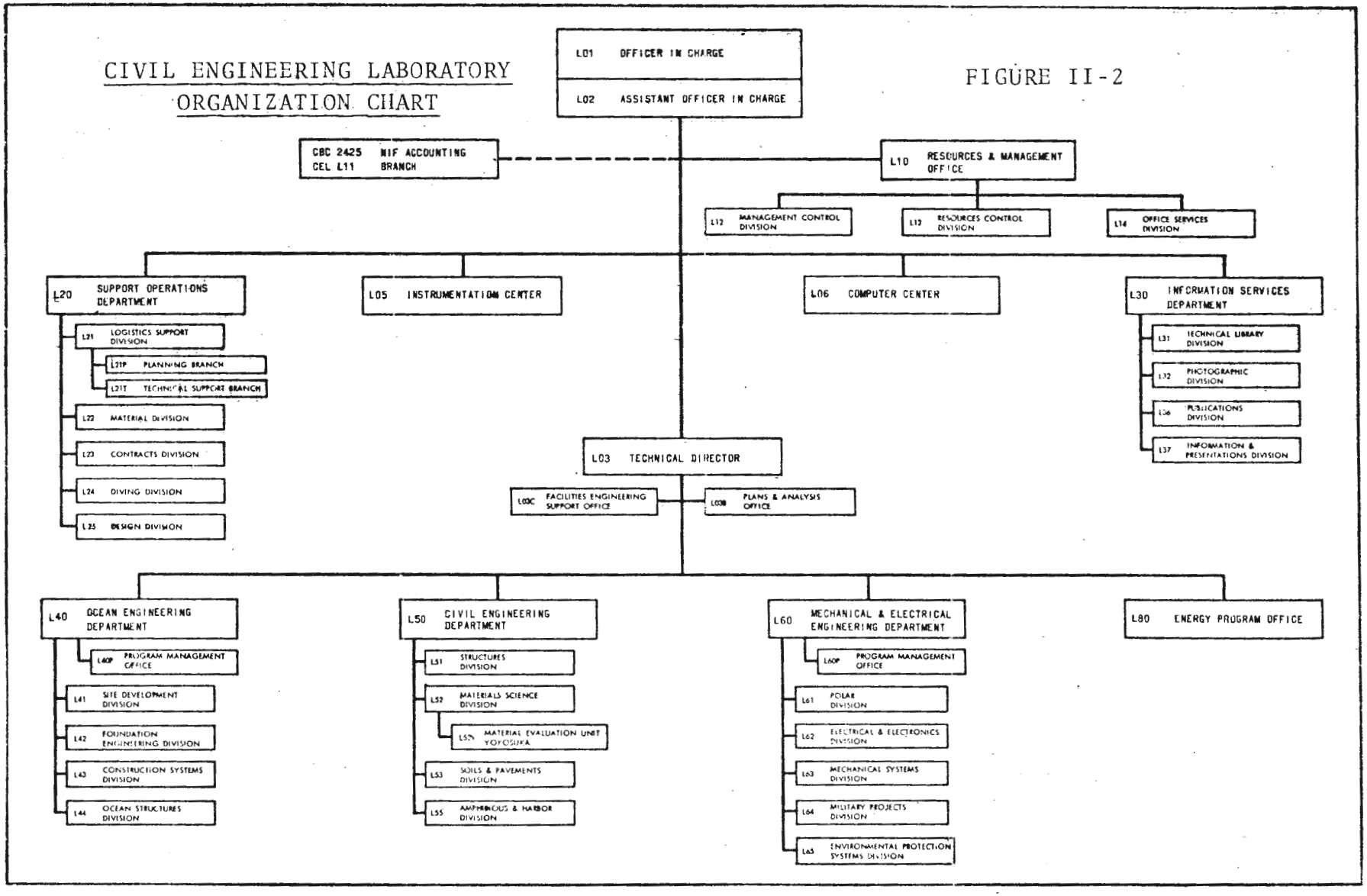
NAVFAC RELATIONSHIPS FOR FACILITIES MATTERS



This figure shows the relationships between the Naval Facilities Engineering Command and the various field units under its cognizance.

CIVIL ENGINEERING LABORATORY ORGANIZATION CHART

FIGURE II-2



Funding for CEL's FY '74 program exceeded $13 million, with 68% of the program supported by Navy RDT&E funds. About $4.2 million were provided for the support of work for various Navy, other DOD and non-DOD sponsors. For FY '74, the bulk of these efforts, about 76%, were in Exploratory Development (applied research). Roughly 1% of effort was in research, and the balance, about 23%, was in Advance Engineering and Operational Systems Development [Ref. 6].

C. NAVFAC'S TECHNOLOGY TRANSFER PROGRAM

The Navy's RDT&E funds are specifically administered by NAVFAC's Assistant Commander for Research and Development (Code 031). This Division has the responsibility also of insuring that the input and output of R&D information is transferred between all levels of the Navy to insure that the maximum benefit from R&D expenditures is obtained. Two specific organizational innovations are funded by NAVFAC in an effort to better coordinate the flow of R&D information from and to the field operating units:

1. In July of 1966, NAVFAC established Research Development Test and Evaluation liaison billets at each Engineering Field Division (EFD) [Ref. 7]. The RDT&E Liaison Officer was intended to serve as NAVFAC's focal point at each of the EFD's to facilitate communication between field activities and NAVFAC in the area of RDT&E and to serve to improve and expedite the evaluation of new ideas, concepts, procedures, new materials, equipment, and to insure feedback to NAVFAC for further dissemination Navy-wide. They would also study technical problems unique to the field forces and transmit to NAVFAC proposals for research effort to initiate corrective measures.

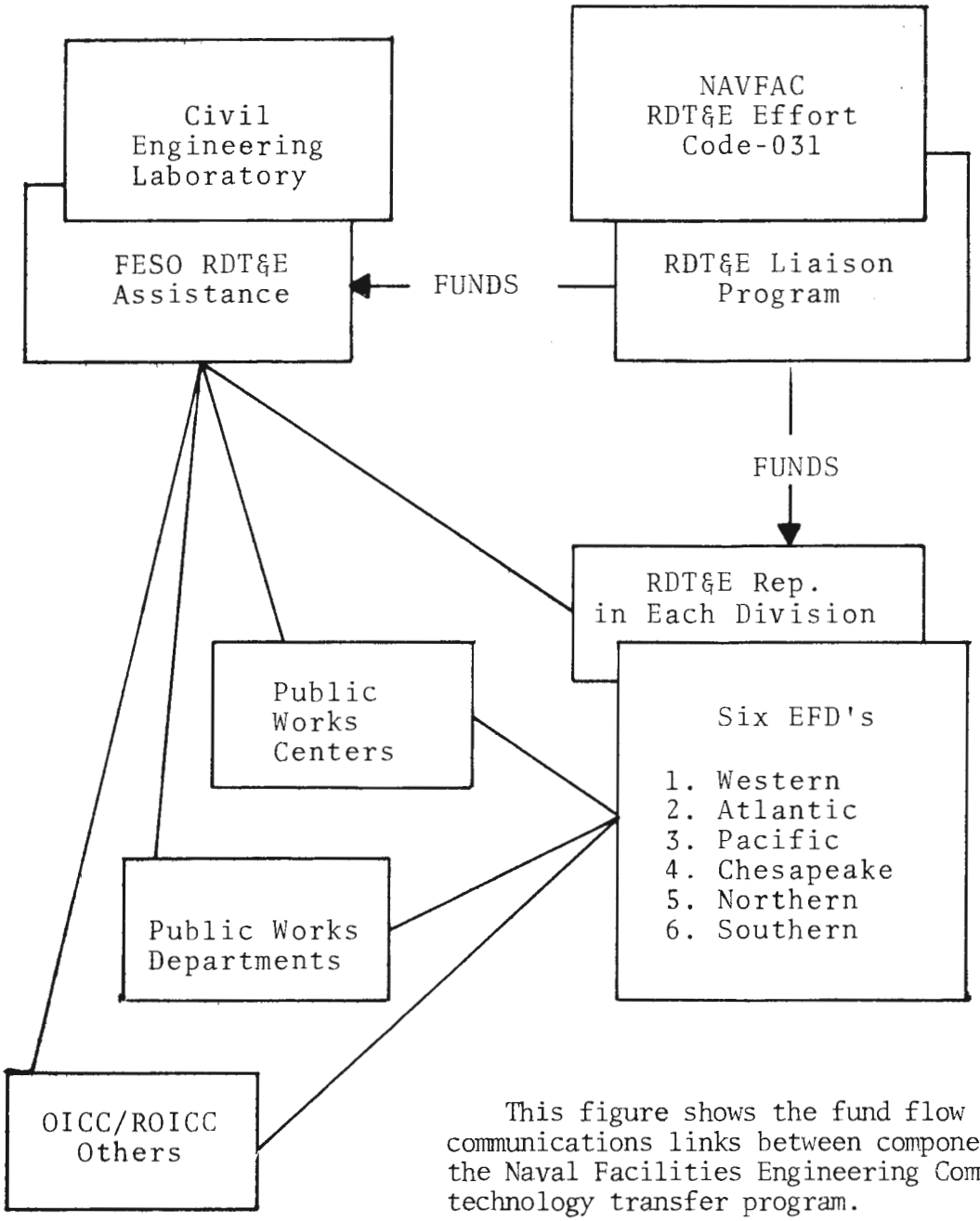
2. In addition to establishing an RDT&E representative in each EFD, NAVFAC advised shore facilities that CEL would provide, upon request and at no cost, services relating

to tests, analysis or similar studies of new materials, equipments, processes, and construction or maintenance techniques [Ref. 8]. To coordinate this effort, CEL established the Facilities Engineering Support Office (FESO) in June of 1971 [Ref. 9].

The interrelationship of these two programs is shown in Figure II-3. The operation of the FESO is described in Chapter III, which follows.

FIGURE II-3

NAVFAC RDT&E LIAISON AND FESO PROGRAMS



This figure shows the fund flow and the communications links between components in the Naval Facilities Engineering Command's technology transfer program.

III. THE FACILITIES ENGINEERING SUPPORT OFFICE

A. FUNCTIONS AND OBJECTIVES

The FESO organization was established by CEL and funded by NAVFAC to perform the function of coordinating services and communications related to RDT&E assistance to Naval shore activities. CEL's internal organization, reflecting the placement of the FESO as a staff component, is shown in Figure II-2. The specific objective of this program was to provide RDT&E assistance to Naval shore activities by having CEL perform short-term services to determine the relative value and suitability of new materials, equipments, processes and construction or maintenance procedures.

The function of the FESO as stated in the instituting notice is as follows:

> Provides timely engineering support services to the NAVFAC and Public Works field activities throughout the shore establishment on facility engineering matters.
>
> Serves as a point of contact in the Laboratory for liaison with field activities on facility engineering RDT&E matters. Develops and maintains an understanding of the functions, internal organizational structure, and staffing of the various field activities, and personal acquaintances with key individuals in the largest and most important activities.
>
> Searches out, develops, and maintains a knowledge of RDT&E assistance needs of these field activities and provides them with a knowledge of CEL's capabilities and interest in meeting their needs.
>
> Acts as project coordinator on RDT&E assistance projects for field activities to ensure timely and effective Laboratory responsiveness to these needs.

Acts as a focal point for correspondence relating to RDT&E assistance to field activities, including promotion of direct contact between NCEL technical staff and field personnel.

Effects utilization of currently available research results as a means of meeting the needs of the field activities.

Formulates plans for RDT&E support of field units by CEL where a solution is not currently available including initiating task proposals and obtaining field activity sponsorship of such RDT&E proposals.

Studies the spectra of RDT&E assistance needs of the field activities, symthesizes these needs and their solutions, and disseminates findings to these field activities/ [Ref. 9]

B. FUNDING AND STAFFING

Conceptually, the FESO is in a liaison position and as such consists at the present time of one civilian. He administers the functions of the office by coordinating and recording the flow of information between the field units and the specific laboratory individuals having expertise in the area of the inquiry. In addition, this office is tasked with assuring that field units are knowledgable of the lab's current programs and the availability of the FESO service. This advertisement function is pursued through various media including leaflets, bulletins and site visits. A 24-hour phone service is also maintained by FESO to handle and record incoming calls world-wide. FY '74 NAVFAC RDT&E funds supporting the FESO program amounted to $272,770. This figure is broken down in detail in Appendix A. In general, CEL's internal guidelines for expenditures of the funds allotted to the FESO provides that assistance requests involving twenty man-hours or less

are handled as a short-term request. Costs in this category are not maintained by specific requests; rather, total numbers of short-term requests and total costs expended thereon per division is recorded. Requests for services involving more than twenty man-hours (or $500) or frequently recurring requests of a similar nature are categorized as job order requests. These requests must be approved by the technical director and specific costs for each request are kept.

C. MONITORING FY '72/'73 FESO PROGRESS

During August of 1972, a meeting was held at CEL, Port Hueneme. The attendance included the RDT&E Liaison Officers from each of the Engineering Field Divisions, representatives from NAVFAC, interested individuals from CEL and invited researchers from the Naval Postgraduate School at Monterey, California. This meeting, in part, discussed the outcome of the first full year's operation of the FESO (FY '72). The program was determined to be beneficial, based on the significant number of requests received, and various means of monitoring the program were discussed in an attempt to better measure its growth, effectiveness and efficiency.

A decision was reached at this meeting to attempt to obtain this type of information for FY '72 by utilizing a "FESO Project Effectiveness" questionnaire (Appendix B). The evaluation process was continued for the FY '73 period by using a slightly modified questionnaire (Appendix C). Special note should be made as to the distribution of the questionnaires. The total number of requests handled by

FESO in FY'72 was 281, and 349 in FY'73. The requests evaluated via the questionnaires were only those initiated from the EFD's. The completion of the questionnaires was coordinated by the NAVFAC RDT&E Liaison Officer located at each EFD and returned to the Naval Postgraduate School for evaluation. The sample size consisted of 83 requests in FY'72 and 93 in FY'73. Evaluation of the returns from these two questionnaires yielded a variety of interesting statistics and trends as to the level of activity, progress, and effectiveness of the program [Refs. 10 and 11].

1. Quantity of Requests

The total number of requests received in FY'72 and FY'73 was 281 and 349 respectively. Appendix D shows a detailed breakdown by requestor. Under the assumption that an increasing number of requests indicated increasing benefit to field activities, the program appeared to be expanding well.

2. Categories of Project Requests

Identifying specific categories of requests by project type is beneficial for determining major problem areas encountered in the field. This information could be utilized in emphasizing future R&D efforts as well as effecting manpower requirements within the laboratory. By far the most common request in both years was in the area of paint and coatings. Requests from FY'72 and FY'73 included 25.3% and 18.3%, respectively, in this category. Other problem areas achieving some significance, ranging from 3% to 12%, included water pollution, classified disposal, structural, corrosion, concrete,

electronic, pavement, mechanical, electrical, and miscellaneous pollution. These areas were in the range indicated; however, the order of magnitude varied between the two years. A comparison of results obtained in the FY'72 and FY'73 studies is shown in Appendix E.

3. Means of Communication

The communication link to and from CEL was considered of vital importance to the program. The communication system must be accessible to those seeking information and also have the ability to transmit comprehensive and timely data. Survey data from FY'72 and FY'73 showed that the telephone was the predominant means of communicating requests from the field to CEL. The use of the telephone increased from 60.2% of total requests in FY'72 to 73.5% in FY'73. Contributing factors to this sizeable increase were the establishment of a 24-hour answering service in the FESO office and emphasis in CEL advertisement of their accessibility by telephone. The survey information also indicated that the telephone was a major means of communicating responses from CEL to the field, 41.5% in FY'72 and 54.8% in FY'73. It should be noted, however, that the data used to calculate the above percentages was based on initial request and initial response. In many cases, letter and message follow up documentation of both request and responses were used.

4. Response Time

One of the objectives of the program was to provide a "rapid response" to field requests. Results of measuring this parameter for FY'72 and FY'73 are as follows:

Per Cent of Total Requests Answered Within Time Period

(Time Period)	1 Day	2 Days	7 Days	14 Days	30 Days
FY '72	26	34	45	57	76
FY '73	31	35	52	65	76

As indicated, the majority of assistance requests were answered within a relatively short period of time. In addition to timely transmission of required information, this rapid response had the further benefit of providing stimulus for additional usage of the program.

5. Utilization of Assistance

An important measurement of FESO program effectiveness is the determination of the degree to which the information obtained from CEL is used by the requesting activities. Both FY '72 and FY '73 questionnaires attempted to obtain a determination of usage. Although the FY '72 questionnaire yielded some conflict in this measurement, it could be concluded that the information provided by CEL was used in 65 to 73% of the cases surveyed. The FY '73 questionnaire yielded approximately the same percentage of utilization as that of FY '72.

6. Dollar Benefit of Assistance

The measurement of the FESO program in terms of dollar benefit was considered desirable. By quantifying the benefits in dollars, the change from one year to the next could easily be measured in meaningful terms. In addition, data to perform cost/benefit judgments on the overall program would be available. Such a measurement is often essential in justifying the continuing expenditure for such a program.

Each year's questionnaires attempted to determine dollar benefits by quantifying within specific ranges the

estimated cost of individual projects, with and without the assistance of the FESO. The mid-point of each range was used as the average value. Using this method, five of the 83 projects in FY '72 had benefits which were quantifiable for a total of $28,250. In FY '73, 28 of the 93 projects were so identified with a benefit of $46,250. The restrictive latitude provided for evaluation of benefits on the questionnaire did not allow for consideration of other factors. The questionnaire permitted benefits to be classified into only two categories; specific dollar savings, or intangibles. In addition, even the dollar savings was highly subjective on the part of the individual filling out the form at the activity level. Several students at the Naval Postgraduate School reviewed each of the FY '73 questionnaires in an attempt in part to subjectively evaluate the benefit question by considering all information available on the specific project. They considered that a number of the positive benefits indicated by the originator of the data were not valid, but on the other hand determined that several other projects would prove beneficial, but had not been listed as such. They concluded that the total savings could have been as high as $496,250 vice the $46,250 arrived at by strictly adhering to the information provided in the benefit questions filled out by the user of the information. In conclusion of this exercise, it is apparent that a better method of measurement of this type of information is necessary.

In addition to the benefits that can be quantified into dollar savings, a significant number of projects were

noted as providing intangible benefits. Examples of these intangibles were: the information reduced the severity of the problem, had applications in solving other problems, or resulted in further research. These benefits were not quantified in the FY '72 or FY '73 studies, but were merely recognized as positive contributions of the FESO program.

IV. THE APPROACH USED IN DEVELOPING A MEASURE FOR DETERMINING THE EFFECTIVENESS OF FESO

A. DETERMINING THE SCOPE OF THE PROBLEM

An essential phase of determining the "effectiveness" of an organization is to establish the criteria by which effectiveness will be measured. The FESO is to be analyzed with respect to its purpose of providing a link to facilitate technological transfer of information from its parent organization (CEL) to requesting field units which have a need for the information.

In this light, the benefit of FESO could reasonably be considered a function of the value of the information transferred by FESO and utilized by a field activity. In other words, the dollar benefits obtained by a field activity utilizing information obtained from CEL would be a measure of the effectiveness of the existing FESO organization. The use of a dollar measurement has intuitive appeal and in fact is probably the most meaningful measurement if its derivation can objectively be obtained. Objectively quantifying the benefits, however, is difficult to do. As Chapter III indicated, past attempts to quantify benefits were highly subjective and led to varying results from identical data. There exists a considerable range of latitude when attempting to quantify the dollar value of the benefit derived from a piece of information. A specific recommendation to solve a particular problem may easily be quantified if it will reduce

out of pocket expenditures to achieve identical results. Factors such as quality of output could, however, tend to cloud even this type of calculation of such "hard core" benefits. Quantifying benefits derived from one piece of information which is only a part of the total information required to arrive at a decision leaves room for even greater subjectivity. At the far scale, quantifying an intangible benefit such as increased morale, safety, and general information probably is the most subjective measurement of all. In essence, any attempt to quantify the benefit of information is necessarily highly subjective, and recognition of this fact is an underlying consideration in the development of the approach.

In addition to quantifying the benefits attributable to the FESO organization as a whole, it is of significant importance to correlate benefits to specific parameters of the information transfer system. Results of such correlation could be used to determine the mix which would optimize the benefits of the system. For example, what type of field activities/individuals obtain the greatest benefit per assistance request? What percentage of activities by type and geographical location are using the FESO service? Answers to both of these questions could provide valuable insight to FESO in an effort to optimize their advertisement effort. There are a number of these type parameters that must be investigated to determine an optimal course of action to maximize the effectiveness of FESO.

B. METHOD OF OBTAINING DATA

The major input of data used as the primary basis of analysis was obtained through use of a revised questionnaire (Appendix F). The total number of assistance requests handled by FESO during FY '74 was 396 (Appendix D). Of this total, 295 requests originating from the shore facilities segment were selected for analysis. Of these 295, the 105 requests originating from the EFD's were again handled by RDT&E representatives to provide continuity to the FY '72 and FY '73 questionnaires. Information on the remaining 190 assistance requests representing direct contact from field support activities (which included PWO's, PWC's and OICC/ROICC's) to FESO was gathered via telephone by researchers at the Naval Postgraduate School. The same questionnaire was used in obtaining information over the phone as was sent to the EFD's. By utilizing the telephone to gather data, it was hoped to obtain an in-depth answer to each question, thus avoiding conflicting answers to various questions, as had been experienced on earlier questionnaires.

C. PREPARATION OF THE FY '74 QUESTIONNAIRE

The changes in the FY '74 questionnaire from the FY '73 version were mainly for the purpose of obtaining better definition and evaluation of the value of the information received from FESO. Information pertaining to quantity of requests, communication means and response time was available from the FESO office itself and was therefore not included on the questionnaire. The categories of project type remained

essentially the same as in the FY '73 version, and information pertaining to this topic was derived from question No. 1, "Description of Project." The FY '74 questionnaire also sought to obtain information as to who was using the FESO service and how they learned of the service.

In regard to quantifying benefits, several changes were made. As a lead-off question in this regard, question No. 2 asked if the assistance was in any way beneficial. If this question received a positive reply, question No. 4 attempted to obtain a description of the degree of utilization of the information. If the assistance was directly beneficial, question No. 5 asked for an estimate of the savings in dollars, if appropriate. Question No. 6 attempted to determine which requests had potential benefit to other activities and therefore warranted consideration for further dissemination. Question No. 7 sought an expression of intangible benefits and was similar to those used in FY '72 and FY '73.

V. MEASUREMENT OF THE VALUE OF INFORMATION: DERIVATION OF THE MODEL

A. THE PROBLEM

In the case where the decision maker is known and a single decision is to be made, the value of a specific piece of information is relatively easy to determine provided that the benefits of the decision are measurable. This is particularly true if the various results of the decision, both with and without benefit of the piece of information in question, is known or can be described probabilistically. The problem involved in measurement of the benefits derived from a technology transfer system or any information network involving numerous types of decisions, decision makers and benefit types, is much more complicated. This process becomes more subjective, relative to the view of any one decision maker, as an attempt is made to narrow the measurement to a common set of figures. The approach taken here is to initially state all the assumptions and uncertainties used to narrow the wide range of benefits into a comprehensible range for general discussion and observation. Additional assumptions are then made in order to narrow the range into a simplified set of figures. These are used to analyze, study, and potentially improve the effectiveness of the specific information system which we have selected as our sample. In this manner it is hoped that, by developing a method of measurement without taking the view of a specific decision maker, any decision

maker with well defined objectives will be able to make his own assumptions and, from the methods on this specific sample case, derive similar methods to evaluate and improve the effectiveness of other technology transfer systems.

B. DEFINITION OF BENEFITS

The value of information or benefits of technology transfer provided by FESO falls into two major categories:

1. The benefits derived by field activities as a result of technological information which flows outward from the lab to the field as a result of FESO.

2. The expected future benefits which field activities will derive as a result of information flowing from the field to the lab through FESO.

The model directly treats only the first of these two categories. However, it appears reasonable that the results of the second would be approximately proportional to the first.

Only benefits to the Navy are considered. A project which benefits the community, for instance, is considered only in the respect that it contributes to good will.

C. THE SIGNIFICANCE OF "INTANGIBLES"

It was observed from the results of the surveys from FY '72 and FY '73 that the major problem encountered had been the fact that unless the benefits derived were easily measurable, they were categorized as intangible benefits and left unquantified. There certainly can be something said for this treatment since the figure which results as the sum of the quantifiable benefits is a rather objective measure. It, however, presented a significant shortfall since the majority

of benefits fell into this intangible area and it was obvious that many were of significant value relative to those included in the quantifiable category. It was obvious that, if the analysis was to have meaning, this intangible or unmeasurable category must be narrowed to a level where the uncertainty therein did not overshadow the measurable category.

The basic approach taken was to identify different distinguishable categorizations by which projects could be easily grouped. In so grouping, consideration must be given to assure that the methods of quantifying benefits within each group are workable within the time resources of both the researchers and persons surveyed. Also, the number of groups must be limited to a meaningful number relative to the limited sample size. Thus, if the survey indicated that the requestor felt that the information which he had received was in any way beneficial, the project would then be categorized into the group which best suited the case at hand. The groups ranged from the easily identified benefits, similar to those quantified in the earlier surveys, through more subjective quantification methods to a final category similar to the "intangible" unquantifiable category of the earlier surveys.

D. CATEGORIZATION OF REQUESTS

Study of the prior year's survey and of initial returns, mostly telephone returns, of the FY '74 survey led to a three-way categorization of each beneficial request. Basically the categorization process, after determination of whether or not

a benefit existed, reduced to the testing of each request with three questions:

1. (First Categorization) Did the information provided take the form of a specific recommendation for solution of a problem or, did it merely provide information which was combined with information from other sources to form a basis on which a decision for action (or in some cases, no action) could be based?

2. (Second Categorization) What is the probability that the information will be acted on? That is, has the information been implemented or is implementation planned or is implementation dependent on results of tests or is the information being evaluated to determine the advisability of implementation?

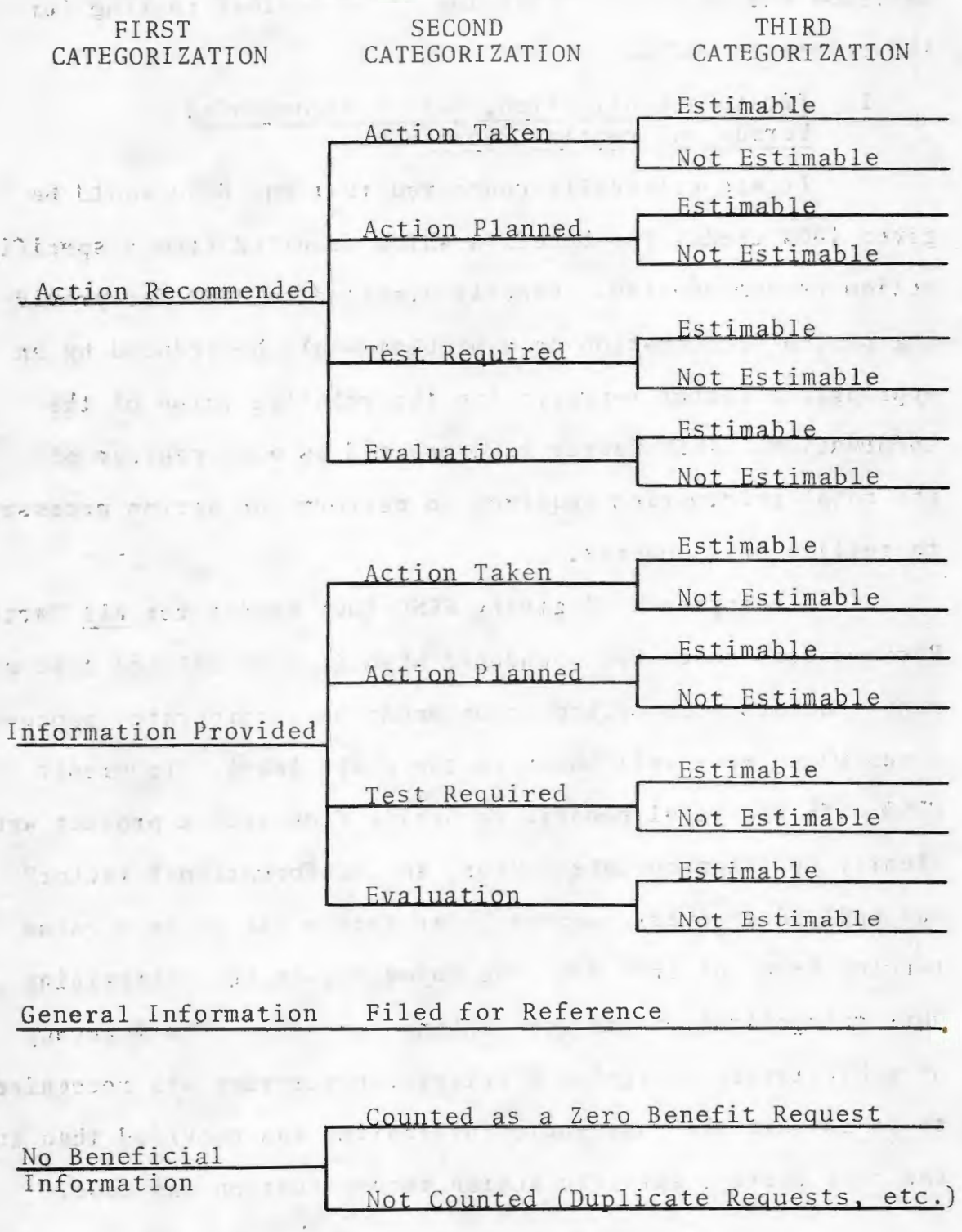
3. (Third Categorization) Is the realized or expected benefit, if implemented, estimable in terms such as reduced cost or eliminated cost?

Figure V-1 shows the complete breakdown of the groups into which a request could fall based on this three-way categorization.

Thus, seventeen different groups or "benefit codes" into which a given beneficial request might be categorized were determined. These ranged from the most easily quantifiable benefits in the first category, "Action Recommended, Action Taken, Estimable" to the final intangible category, "General Information, Filed for Reference." In addition to deriving standard methods of quantifying the present value of expected benefits for each case, it was also desirable to arrive at an ordinal ranking of the subjectivity of these benefit codes in order that results could be displayed in such a way that the reader would have an understanding of the relative effects of the subjectivity. The following subsections describe how various subjective factors were determined to be appropriate

FIGURE V-1

ASSISTANCE REQUEST CATEGORIZATION



This figure depicts the three-way categorization process applied to each assistance request.

for each phase of the three-way categorization process and describe the methods of arriving at an ordinal ranking for the seventeen codes.

1. First Categorization, Action Recommended Versus Information Provided

It was originally conceived that the FESO would be given 100% credit for benefits which resulted from a specific action recommendation. Benefit credited to FESO for providing partial information on a problem would be reduced by an appropriate factor representing the relative value of the information. This factor is expressed as a percentage of the total information required to perform the action necessary to realize said benefit.

The approach of giving FESO 100% credit for all "Action Recommended" cases was abandoned when it was realized that on many requests much of the recommendation incorporated procedures which were well known at the field level. To credit FESO with the total benefit resulting from such a project would clearly be inappropriate. Thus, the "information-%-factor" was applied to every request. The factor was given a value ranging from .01 to 1.00. The major reason for maintaining this categorization was for ranking purposes. The accuracy of subjectively assigning a relative percentage was recognized to be less in the case where information was provided than in the case where a specific action recommendation was made.

2. Second Categorization, Probability of Implementation

Cases which had results considered beneficial were classified into one of the following categories which are listed in descending order according to the probability of implementation of the information provided:

1. Information has been implemented. (Action Taken)

2. Implementation is planned. (Action Planned)

3. Testing is planned or underway; implementation is intended if tests are successful. (Test Required)

4. Information is being evaluated; implementation is intended provided evaluation indicates that expected benefits are probable; testing may be necessary. (Evaluation)

5. The information provided was of a general type; not related to a specific project. (General Information, Filed for Reference)

Based on experience of the researchers,[1] probabilities were assigned to each of the middle three categories (2, 3, 4 above) and that factor applied to the benefit which would be expected if the project were implemented. The first category required no factor (or a factor of 1.0) since implementation had already been accomplished. The fifth category was left unquantified and is treated separately in a later section.

3. Third Categorization, Quality of Dollar Estimation

a. Estimable Projects

Projects with dollar savings specifically identified on the FY 74 questionnaire (Appendix F, Question 5)

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[1]Two of the researchers are Naval Civil Engineer Corps Officers with a combined total of 18 years' experience in shore facilities management.

were classified as estimable. If the identified savings were of the one-time type (versus recurring), the amount so identified was used as the project benefit. The benefit credited to FESO in such a case was the project benefit reduced by the factor for implementation probability and the information-%-factor as appropriate. If estimable identified savings were of the recurring type, the project benefit used was the present value of the first five years of savings. A present value factor of 3.935 for a steady cash flow throughout the year utilizing a 10% rate of return was used. Again, the benefit credited to FESO was the project benefit reduced by appropriate factors as done above.

b. Not-Estimable Projects

Beneficial projects which did not have specifically identified dollar savings generally fell into areas where the benefit was in the form of improved operations, better morale, increased safety, etc. In the FY '72 and FY '73 surveys, benefits of projects of this type were left unquantified. With the exception of requests which fell into the general information type, each request had an identifiable benefit even though it was not readily quantifiable in terms of direct dollar savings. Each could in some way, however, be identified with a project, the magnitude of which was normally relatively easily quantified.

At this point, an assumption upon which a major portion of the analysis is based had to be made. It was assumed that, in order to commit funds to a project, a

decision maker must, whether he realizes it or not, expect a return in future benefits which is some percentage greater in present value than the initial outlay. This percentage may vary from decision maker to decision maker and will even vary with time under varying circumstances for any given decision maker. Even if the expected percentage were constant over various decision makers and over time, it would be expected that the average return actually realized would vary depending on the quality of the decision maker. As a result, a further, rather obvious assumption must be made. It is assumed that the decision makers in the Navy, who decide on the implementation of FESO information, are of quality such that the results of their decisions yield an average positive benefit over the range of projects examined. Approximately 100 of 295 requests in the FY '74 survey fell into this unestimable category.

Based on the above assumptions and the significant number of requests, it is considered that careful selection of an average percentage (of benefit over initial outlay) applied to the magnitude of each project would yield a reasonable dollar benefit.

The next task was selection of the appropriate project magnitude. One of the less complex examples of this selection of project magnitude would be the case of a modification to an existing piece of equipment which would result in some unquantifiable benefit. In this case, the project magnitude would be the cost of the modification. One of the most complicated examples would be the case where a piece of

equipment was due to be replaced and the information provided through FESO caused the replacement to be accomplished through procurement of a different type of item which was more beneficial. Assuming that the cost of the replacement item was essentially the same as the original, use of the total procurement cost of the replacement as the magnitude of the project would clearly be inappropriate. On the other hand, to use a zero magnitude would be just as inappropriate. It is obvious that some value within these two extremes is more accurate. Although each case was considered individually, a value for the project magnitude between these two extremes was chosen by subjectively considering to what extent the non-dollar benefit of the new type procurement increased relative to the total benefit which would have accrued by replacing the item in kind. The percentage increase in benefit was applied to the cost of procurement and that figure used as project magnitude.

4. Ordinal Ranking of Benefit Categories

The application of appropriate factors to project benefits which are estimated in accordance with the methods described in the last section yields the benefit to be credited to FESO for each case. As discussed previously, this figure varies in subjectivity among the benefit categories shown in Figure V-1. The subjectivity, for the major part, lies in the selection of the value assigned to the various factors used. Some factors can be identified as being more subjective than others. The ranking method decided upon consists of initially arranging the categories in groups from

the less subjective to the more subjective by considering the number of factors used. (Higher number of factors yields greater subjectivity.) Then the categories within the groups were arranged by considering the subjectivity of each factor. The resulting ranking, together with the formula for each category as derived in the previous sections, is shown below:

Group I - One Factor

Benefit Code 01 - Action Recommended, Action Taken, Estimable.
Benefit of FESO = (project benefit) x (information-%-factor)

Benefit Code 02 - Information Provided, Action Taken, Estimable.
Benefit of FESO = (project benefit) x (information-%-factor)

Group II - Two Factors

Benefit Code 03 - Action Recommended, Action Taken, Not Estimable.
Benefit of FESO = (project magnitude) x (benefit-%-factor) x (information-%-factor)

Benefit Code 04 - Action Recommended, Action Planned, Estimable.
Benefit of FESO = (project benefit) x (planning factor) x (information-%-factor)

Benefit Code 05 - Information Provided, Action Taken, Not Estimable.
Benefit of FESO = (project magnitude) x (benefit-%-factor) x (information-%-factor)

Benefit Code 06 - Information Provided, Action Planned, Estimable.
Benefit of FESO = (project benefit) x (planning factor) x (information-%-factor)

Benefit Code 07 - Action Recommended, Testing Required, Estimable.
Benefit of FESO = (project benefit) x (testing factor) x (information-%-factor)

Benefit Code 08 - Information Provided, Test Required, Estimable.
Benefit of FESO = (project benefit) x (testing factor) x (information-%-factor)

Benefit Code 09 - Action Recommended, Evaluation, Estimable.
Benefit of FESO = (project benefit) x (evaluation factor) x (information-%-factor)

Benefit Code 10 - Information Provided, Evaluation, Estimable.
Benefit of FESO = (project benefit) x (evaluation factor) x (information-%-factor)

Group III - Three Factors

Benefit Code 11 - Action Recommended, Action Planned, Not Estimable.
Benefit of FESO = (project magnitude) x (benefit-%-factor) x (planning factor) x (information-%-factor)

Benefit Code 12 - Information Provided, Action Planned, Not estimable.
Benefit of FESO = (project magnitude) x (benefit-%-factor) x (planning factor) x (information-%-factor)

Benefit Code 13 - Action Recommended, Test Required, Not Estimable.
Benefit of FESO = (project magnitude) x (benefit-%-factor) x (testing factor) x (information-%-factor)

Benefit Code 14 - Information Provided, Test Required, Not Estimable.
Benefit of FESO = (project magnitude) x (benefit-%-factor) x (testing factor) x (information-%-factor)

Benefit Code 15 - Action Recommended, Evaluation, Not Estimable.
Benefit of FESO = (project magnitude) x (benefit-%-factor) x (evaluation factor) x (information-%-factor)

Benefit Code 16 - Information Provided, Evaluation, Not Estimable.
Benefit of FESO = (project magnitude) x (benefit-%-factor) x (evaluation factor) x (information-%-factor)

Benefit Code 17 - General Information, Filed for Reference.
Benefit of FESO = unquantified.

This ordinal ranking in itself appears somewhat subjective when adjacent categories are compared. There was considerable discussion and disagreement among researchers as to the precise rank of adjacent categories. It was agreed, however, that when one looks at the list from a general

standpoint, the ranking does provide an accurate representation of the overall increasing level of subjectivity.

5. Determining Appropriate Values for Factors

The information-%-factor was assigned to each case on an individual basis. The total information available on the case was reviewed by the two researchers with first-hand experience in Shore Facilities Management. The factor was selected from the range of .01 to 1.0 based on the relative effects the FESO-provided information had on the selection of the most beneficial alternative available. Other considerations in the selection of a factor value were the availability of the information from other sources and the relative benefit of the next best alternative that may have been selected had the FESO-provided information not been available.

It was decided to determine values for this factor on an individual case basis instead of attempting to apply an average factor to all cases because there was no information available which indicated an equitable method of selecting the appropriate average. Furthermore, the experience of the researchers did not provide even a subjective feeling as to what an appropriate average figure would be. Although this study does not attempt to identify an appropriate average or even identify the average of the values used, a listing of the information percentage factors are included in the basic data. Future researchers may find them useful through direct use or extrapolation to apply an average factor for analysis of a similar information transfer system.

A probability value for the implementation factors: planning factor, testing factor and evaluation factor were selected and applied to all cases as appropriate. In this case, as opposed to selection of the information-%-factor, the researchers had substantial experience to rely on concerning the probability of implementation of projects which were at various levels of development. The starting point in determining the value of the factors was to choose the least subjective of these three factors. The easiest to discuss was the planning factor. Cases that were in the Action Planned category very closely resemble the backlog of projects awaiting funding or approval by high authority. This backlog exists at every Navy shore facility. Based on first-hand experience gained during assignments in Public Works and Construction Contract Administration positions, a mean probability of 0.5 was assigned as the planning factor. It was felt that this estimate could be inaccurate to the degree that figures could vary anywhere in the range 0.4 to 0.6. The effects of the extremes on the total FESO benefits will be examined and presented in a later section. The testing and evaluation factor values were determined in a similar manner, but the subjectivity of the estimate increases from planning factor to testing factor to evaluation factor. The most objective consideration is the fact that the probability of implementation should be less for projects classified as Test Required than for those classified as Action Planned and less yet for Evaluation. The values and ranges agreed

on for the probability of implementation factors were as follows:

	Mean	Range
Planning Factor	0.5	0.4 - 0.6
Testing Factor	0.3	0.2 - 0.4
Evaluation Factor	0.2	0.1 - 0.3

The benefit-%-factor was chosen as an average to be applied to all cases in the same method as the probability of implementation factors were applied. As discussed in the introduction to this section, for a decision maker to decide to implement a project he must expect some minimum returns, the present value of which exceeds his initial outlay by some percentage. It appears that a reasonable value for this factor would be 0.10. This would be a minimum expectation. Many projects whose expected return exceeds this minimum would also be undertaken. Of course, the actual benefits of a project may fall short of the expectation and yield substantially less than 10%. Since these two typical occurrences tend to counter one another, it was determined that a factor value of 0.10 still appeared to be the most appropriate even after their consideration. The best estimates of the range within which the factor might still be considered reasonable was 0.05 - 0.20.

VI. APPLICATION OF THE MODEL TO FY '74 SURVEY DATA

A. SUMMARY OF SURVEY DATA

The FY '74 survey included 295 requests. FY '74 questionnaires were completed on each of these requests, 105 through the six EFD RDT&E representatives, and the remainder by researchers at the Naval Postgraduate School, Monterey, California, based on telephone interviews with the original requestor. Appendix G shows the procedure by which information from the questionnaire was translated to IBM cards for various computations by the computer program. Printouts are available upon request to the advisors of this thesis. Of these 295 questionnaires, 233 indicated that the requestor considered that he had received beneficial information. The remaining 62 questionnaires indicated that the request yielded no beneficial information. However, among these were 40 cases which indicated that there were extraordinary circumstances indicating that these cases should not be included as zero benefit requests, but rather should be eliminated from the sample for purposes of cost benefit analysis and study. Most common among these extraordinary cases were:

1. The request was merely a follow-up on a previous request. The benefits were totally included on the original request number and were listed on this one as zero to avoid double counting.

2. The lab had requested additional information on the problem from the originator but the information was not provided.

3. No information was available on the benefits portion of this request. (The case is included in the survey for purposes of analyzing originator, position, activity, etc.)

Table I shows the tabulation of the numbers of cases and the total benefits calculated for each category based on the formulas derived in Chapter V. This table shows three figures for the benefits in each category. The three represent calculations based on use of: the mean, the high, and the low values of the three factors applied in the formulas. Figure VI-1 shows the plotted values indicating the increasing uncertainty as the cumulative benefits progress to include more subjective estimates.

B. ANALYSIS OF THE CUMULATIVE BENEFITS CURVE

The curves shown on Figure VI-1 result from drawing smooth curves through the points derived from Table I. They represent graphically the fact that, as the benefits of a greater percentage of cases in the sample are quantified, (a greater number of subjective estimates are included) the total estimate of cumulative benefits becomes more subjective. The vertical distance between the "high" and "low" curves at any point on the horizontal scale represents the range within which the estimate could reasonably be expected to vary due to differing personal values of estimators or decision makers.

Although not by any means an analytical proof, the curve tends to intuitively verify the applicability of the model. As intuitively expected, the benefits from the highly intangible cases are less than those from the more tangible ones, as indicated by the decreasing slope of the curves.

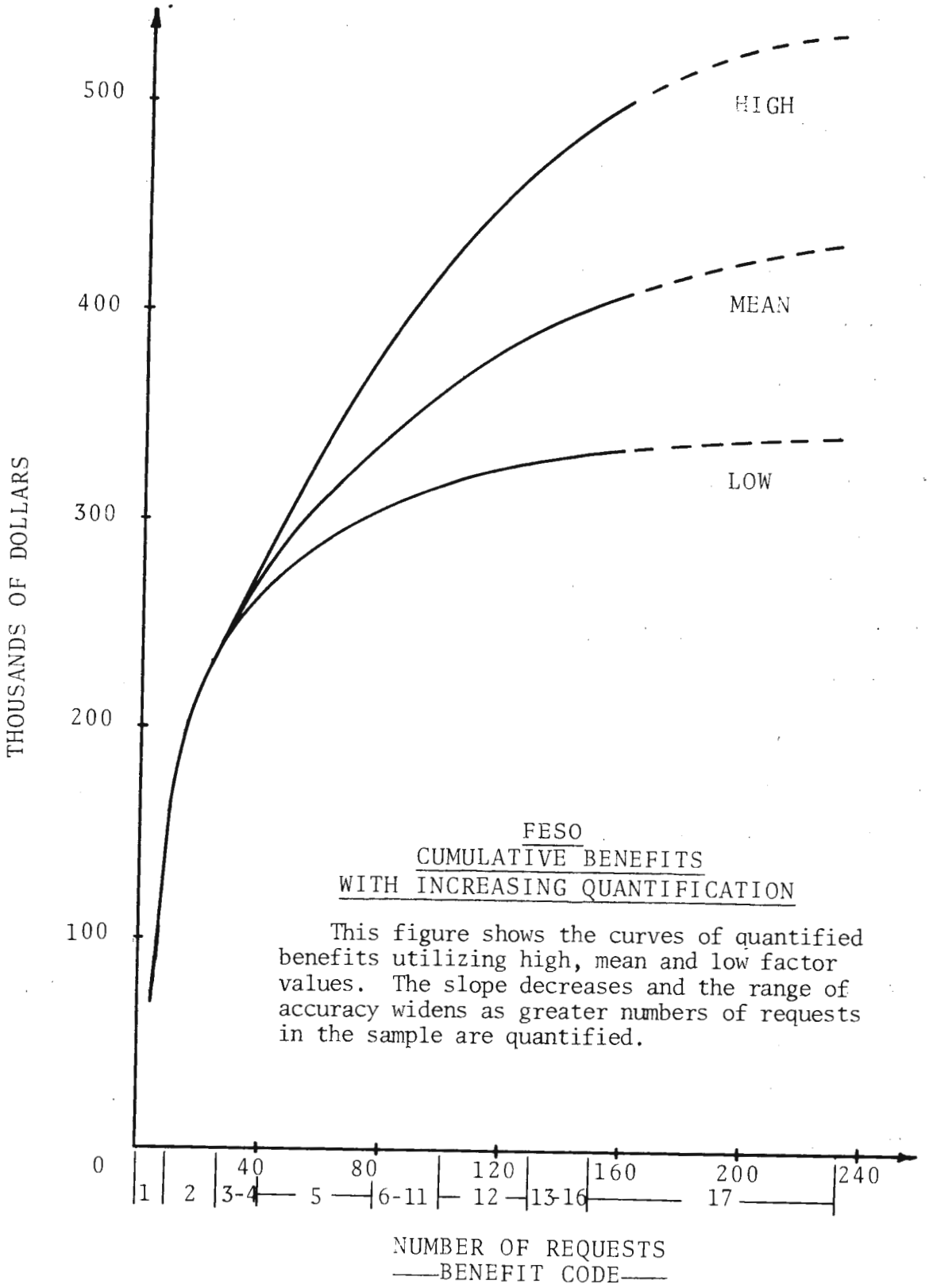
TABLE I

QUANTIFIED BENEFITS FOR FY '74 FESO OPERATION

Benefit Code	Number of Requests	Low Value	Mean Value	High Value	Mean W/O 22 J.O.'s*
Not Counted	40	-----	-----	-----	-----
Zero Benefit	22	0	0	0	0
1	10	206,488	206,488	206,488	11,139
2	17	47,873	47,873	47,873	47,873
3	13	2,344	4,690	9,381	4,690
4	1	8,000	10,000	12,000	10,000
5	38	6,916	13,835	27,670	12,165
6	5	7,399	9,250	11,099	9,250
7	2	6,716	10,074	13,432	0
8	6	34,974	52,460	69,947	52,460
9	0	0	0	0	0
10	1	236	472	708	472
11	8	6,152	15,380	36,912	12,330
12	30	5,664	14,160	33,984	12,160
13	3	470	1,410	3,760	1,410
14	5	3,015	9,045	24,120	9,045
15	1	45	180	540	180
16	11	487	1,950	5,350	1,270
17	82	--Unquantified---		Unquantified--	
Totals	295	336,779	397,267	503,764	184,444

*This column is included for use in Chapter VI.

FIGURE VI-1



FESO
CUMULATIVE BENEFITS
WITH INCREASING QUANTIFICATION

This figure shows the curves of quantified benefits utilizing high, mean and low factor values. The slope decreases and the range of accuracy widens as greater numbers of requests in the sample are quantified.

This intuitive approach is further strengthened by the observation that a decision maker will generally give less weight to the more intangible benefits when confronted with the choice of whether or not to spend today's very tangible dollars for future benefits.

An interesting, though highly subjective addition to the smooth curve resulting from the plotted points on Figure VI-1 is the dashed line extensions of the curves. It is conceivable, although considered too subjective for further consideration in this study, that a decision maker's requirement for quantitative information could be satisfied by extrapolation beyond the plotted points in order to give some indication of the value of the benefits of the cases which fell into Benefit Code 17. In attempting such an endeavor, care must be taken to assure that the end points of the curves very nearly approach the horizontal. This statement is made after observing that there were some extreme, very doubtful cases which were classified into Benefit Code 17. For example, there were a few cases where very general information was requested concerning the state of the art of certain materials. By wording of the request, the position of the requestor, and the nature of the information provided, it was opened to doubt as to whether the information was filed for potential future use or immediately forgotten. On the other extreme were cases which obviously had high future benefit potential.

For the purposes of the analysis made throughout the remainder of this study, the benefit value utilized will include Benefit Codes 01 through 16 only and will be based on mean factor values.

C. COMPARISON WITH PAST YEARS' SURVEYS

The FY '74 survey methods, in large part, have resulted from experience gained from FY '72 and FY '73 surveys. Many questions have been changed to some degree each year in an effort to obtain better data. One disadvantage of the continuous change is the fact that the figures are not strictly comparable from year to year. This comparison is necessary, however, in order to show trends over time.

Data from the FY '74 survey is similar to that of the earlier surveys in all areas except the dollar value estimates of benefits. The major differences between the FY '74 and earlier data in the area of quantifiable benefits is shown below:

FY '72/'73 Surveys

1. Only readily estimable cases which had been implemented were included.

2. Of the total Shore Facilities requests received (excluding NAVFAC requests) 40% were surveyed.

3. Where annual savings were identified, the project benefit was calculated as five times the annual savings.

4. The total project benefit was used as the benefit of FESO.

FY '74 Survey

1. Any benefit which could be reasonably quantified was used. Projects with future implementation potential were included and the benefits thereof were reduced by applying a probability factor.

2. All Shore Facilities requests were surveyed (excluding NAVFAC requests).

3. Where annual savings were identified, the present value of five-year savings was used (approximately 3.9 times the annual savings).

4. An information-%-factor was applied to the project benefit to arrive at the benefit of FESO. (The mean value of the factor was 37% in the FY '74 survey.)

The dollar benefit figures computed by FY '74 survey methods must be adjusted to be comparable to the earlier survey figures for purposes of examining trends.

The cases in the FY '74 survey which were classified into Benefit Codes 01 and 02 are equivalent to the cases quantified in the FY '72/'73 surveys. The quantified benefits under these two codes total $66,662.[2] Adjusting this figure downward by a factor of 0.4 to $26,665 compensates for the 40% sample of the FY '72/'73 surveys. Further adjusting upward by dividing by 0.37 to $72,068 compensates for use of the information-%-factor in FY '74. Approximately 83% of the readily estimable savings (from Benefit Codes 01 and 02) in the FY '74 survey were of the annual recurring type. The resulting adjustment for use of the present value factor (472,068 x 3.9 x 5 x .83) yields $76,688.

Table II shows a comparison of the adjusted quantified and intangible benefits of the three years using FY '72/'73 methods. By a similar method, the FY '72 and FY '73 survey data can be adjusted to reflect results as if the FY '74

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[2] This figure excludes one project, quantified at $187,000. This project is considered extraordinary and not of a recurring type and should, therefore, not be included at this point.

methods were applied to all three years. Figure VI-2 shows a graphical comparison of all three years utilizing both the FY '72/'73 and the FY '74 survey methods. The extraordinary cases (see Table II) have been eliminated since it is inappropriate to include them in projections--backward or forward. It should be noted, however, that over the long term extraordinary cases of this type may constitute a significant portion of realized benefits. At this time the relative time span examined does not support including them in the projections.

TABLE II

EXAMINATION OF FESO BENEFIT TRENDS
FY '72/'73 SURVEY METHODS

Description	FY '72	FY '73	FY '74
No. of Shore Facility Requests	212	282	295
Per Cent Surveyed	40	37	40*
FESO Benefits from Surveyed Cases	$28,000	$46,000	$77,000*
Extraordinary Benefits**	---	$150,000***	$187,699
Other Activity Use	---	---	69%
More than One Project	16	12	7*
Stimulated Solution	5	21	7*
Reduced Severity	16	35	29*
Morale	---	---	9*
Education	---	---	73.2*
Safety Factor	---	---	14*
Other Intangibles	20	27	9*

* These FY '74 figures have been adjusted for comparison.

** Non-recurring, not to be included in projections.

*** Rough estimate--survey data was unclear

FESO BENEFIT TRENDS (THOUSANDS OF DOLLARS)

BY FY 72-73 SURVEY METHODS*

BY FY 74 SURVEY METHODS

* Based on 40% sampling

FIGURE VI-2

VII. COST/BENEFIT ANALYSIS OF THE FY '74 FESO PROGRAM

A. COMPARISON OF OVERALL COSTS AND BENEFITS ATTRIBUTABLE TO FY '74 SURVEY REQUESTS

This study evaluated only 295 requests of the total 396 that the FESO office recorded during FY '74. These 295 requests consisted of all submittals from the EFD's, PWD's, PWC's and OICC/ROICC's. Therefore, with respect to total requests the analysis represented 75% of the FESO effort. The value of the benefits attributable to these 295 requests, as measured by the model developed in Chapter V, amounted to $397,267 (using mean factor values from Table I).

The total cost of the FESO for FY '74 is shown in Appendix A. Only the portion of the total cost applicable to the 295 requests would be appropriate for the analysis. These costs are:

273 short-term requests from PWD's, PWC's, EFD's, OICC/ROICC's	$48,841
22 job order requests submitted in FY '74 from PWD's, PWC's, EFD's, OICC/ROICC's ..	66,346
FESO administrative expenses, proportioned as to total assistance requests processed 295/396 x 41,494 = 30,911	30,911
	$146,098

Evaluation of the FESO program within the framework developed above indicates that there is a return of $2.72 for every dollar spent ($397,267/$146,093).

B. COMPARISON OF COSTS AND BENEFITS OF SHORT-TERM REQUESTS FROM THE FY '74 SURVEY

The primary purpose of the FESO, as discussed previously, is to provide a rapid response to requests for assistance from field operating units. Under this criteria, the appropriate costs should include direct expenditures for the 273 short-term requests, plus an appropriate proportion of the administrative costs. Thus, expenditures for these short-term requests total $77,447 [$48,841 + (273/396 x $41,494)]. The dollar value of the benefits from these 273 requests is $184,444 (last column of Table I). Therefore, the return of the FESO program for these short-term requests is $2.38 for each dollar spent.

C. COMPARISON OF COSTS AND BENEFITS OF JOB ORDER REQUESTS FROM THE FY '74 SURVEY

Twenty-two of the 296 FY '74 requests developed into specific job orders. Benefits from these 22 job order requests amounted to $212,823 ($397,267 - $184,444). The costs thereof include direct expenditures plus an appropriate proportion of administrative costs. Thus, the costs total $68,651 [$66,346 + (22/396 x $41,494)]. The benefit-to-cost ratio in this case is $3.10 per dollar of expenditure.

The payoff in this area appears promising; however, several factors would make such an assumption questionable. The small number of requests involved may not give a representative sample. In fact, one of the 22 requests involved an exceptionally high benefit value of $187,699 with a cost of only $2,479. If this request was omitted, the payoff on

the remaining 21 requests amounted to only $0.38 for each dollar expended. This negative return could perhaps be justified in the short run (less than, say, five years) if the project expenditure is intended to provide a long-term benefit that would have possible application to a number of users. However, for the purpose of this study, any conclusion as to the overall cost/benefit ratio within this specific project category is considered impractical due to the limited number of projects within this grouping, the tremendous range of values, and the defined time frame of analysis.

D. COMPARISON OF COSTS AND BENEFITS WITH RESPECT TO PROJECT TYPES

Data made available from CEL provided the average cost per short-term assistance request for each specific division within the laboratory. A breakdown by project type of the number of requests handled by each division, as well as the average request cost for each division, is shown in Appendix H.

Appendix I shows the value of the benefits attributed to each of the project types. Values from these two appendices are combined into Table III to provide a cost/benefit comparison by specific project type. Several project types with low utilization, which could not logically be grouped with other types, were omitted. Other project types with low utilization were grouped together or combined with high utilization types, as appropriate.

In evaluating the profit or loss per request by categories displayed on Table III, it is apparent that requests dealing

TABLE III

COST/BENEFIT COMPARISON OF FY '74 SHORT-TERM REQUESTS BY PROJECT TYPE*

Project Type	No. of Requests	Total Benefit	Total Cost	Total Value	Value per Request
Paint Coatings, Chemical, Waterproofing	72	31,196	12,755	18,441	256
Pavements	21	10,481	4,432	6,049	288
Pollution	14	5,537	3,519	2,018	144
Corrosion	12	5,380	2,082	3,298	275
Building Materials, Concrete, Resins and Plastics	18	636	3,096	(2,460)	(137)
Disposal	18	7,424	3,102	4,322	240
Electrical, Electronic	16	6,401	2,602	3,799	237
Structural	16	29,545	3,461	26,084	1,630
Roofs	16	883	2,752	(1,869)	(117)
Mechanical	18	26,015	3,653	22,362	1,242
Energy Conservation	19	52,443	2,277	50,166	2,640
Other	33	8,503	---	---	---
Job Orders	22	---	---	---	---
TOTAL	295	$184,444	$43,731	$132,731	

* Includes only requests from PWC's, PWD's, EFD's and OICC/ROICC's.

with energy conservation, mechanical problems, and structural problems offer the greatest payoff. Projects in the areas of roofing, building materials, concrete, plastics and resins do not yield sufficient benefit to cover the expense of providing assistance. The remaining six project types all have a positive benefit ranging from $144 to $288. It should be pointed out that the profit per request does not include the FESO administrative cost of $30,911. If this figure was apportioned equally over the total 295 requests, an additional cost of $105 could be added to each request. Taking this cost into consideration will not change the relative ranking of the project types, nor do any of the profitable types shown on Table III change to losses.

Care must be taken in assessing the results of Table III. There are several factors not apparent from the table which may lead to erroneous conclusions. For example, one project within the energy conservation category contributed a benefit of $37,776. If this one project was deleted, the profitability of this category would change dramatically. In general, however, the cost per request does not fluctuate to the extent that the benefit per request does. Therefore, any project type with several high benefit projects will appear more favorable on a value per request basis. A plausible explanation for low value of requests in the roofing and building materials, concrete, plastics and resins types is that most information provided by the CEL in this area had a low information-%-factor since, in general, this type of information

is not heavily dependent on technology and is available in the private sector.

VIII. FESO SYSTEM OPTIMIZATION

Previous chapters have developed methods of measuring the benefits of the FESO system. The utilization of this measurement for purposes of program justification has been demonstrated in Chapter VII. Through application of cost/benefit analysis, optimization along system parameters, that of project type, was begun. The purpose of this chapter is to further demonstrate how optimization along system parameters can be accomplished. The thrust is threefold: first, the identification of parameters where high cost/benefit ratios exist; second, investigation of the field (market) to determine whether and where an opportunity exists to capitalize in these areas; and third, to further examine system parameters to identify methods by which this optimization can be pursued. In this chapter, two cases are omitted from the 295 surveyed. Both are high valued in terms of the benefit resulting from the quantification process and are considered extraordinary and not representative of expected performance in any of the particular categories being examined. The benefit of FESO for each, calculated by using the mean factor values of Chapter V, is $37,776 and $187,699.

Section D of Chapter VII examined the benefit-to-cost ratio by project type of the cases surveyed less the 22 job order cases. In general, the results showed that the difference in average cost by project type was relatively small compared to the difference in average benefits.

Due to the laboratory's method of recording cost data for these small cost projects, no information could be obtained on the average cost per request by the other categories of interest, e.g., originator, activity type or EFD area. For this reason and due to the fact that there is no indication that any patterns of average cost differences over these areas exist, the analysis of this chapter is based solely on benefits. The tacit assumption is that the relative ranking within categories will be unaffected by cost since the costs per request within a given category are equal.

A. CORRELATION OF BENEFITS TO SPECIFIC SYSTEM PARAMETERS

1. Correlation of Benefits by Project Type

The ranking of grouped types within this category has been accomplished in Section VII D by use of benefit-to-cost margins. The purpose of this section is to demonstrate that the relative ranking does not appreciably change when only benefits are considered. Table IV shows the average benefit for each project type. After again grouping similar codes and eliminating codes where limited numbers of requests preclude a meaningful average, the relative ranking and average benefit per request of each group is as shown in Table V. It should be noted that the ranking is essentially the same as that resulting in Section VII D. Also included in Table V are the average benefits per case when the Benefit Code 17 cases are included. It should be noted that the two methods of ranking in Table V, as well as that in Section VII D, essentially result in the same conclusion. Highest on the

TABLE IV

VALUE OF BENEFITS BY PROJECT DESCRIPTION
(293 Cases--Two Extraordinary Cases Omitted)

Code		No. of Requests	Quantified Benefits	Benefit/ Requests
01	Paints and Coatings	44	$28,226	642
02	Pavements	11	14,981	1,362
03	Waterproofing	4	6,748	1,687
04	Water Pollution	9	5,637	626
05	Miscellaneous Pollution	1	50	50
06	Concrete	4	925	231
07	Corrosion	9	5,700	633
08	Pile and Camels	4	925	231
09	Building Materials	4	160	40
10	Classified Disposal	5	6,224	1,245
11	Unclassified Materials	9	2,330	259
12	Plastics and Resins	1	300	300
13	Explosive Damage	2	1,800	900
14	Seismic Effects	0	0	---
15	Electrical	8	6,400	800
16	Electronic	0	0	---
17	Structural	12	29,545	2,462
18	Roofs	7	882	126
19	Mechanical	19	39,308	2,069
20	Energy Conservation	6	14,666	2,444
21	Moorings	9	5,275	586
22	Other	3	1,710	570
		171*	$171,800	

* 82 Benefit Code 17 cases and 40 not-counted cases not included.

TABLE V

RANKING OF PROJECT TYPES BY AVERAGE BENEFIT/REQUEST
(293 Cases--Two Extraordinary Cases Omitted)

			Benefit Code #17 Omitted		Benefit Code #17 Included		
Rank	Code	Description	No. Req.	Average Benefit	No. Req.	Average Benefit	Rank
1	17	Structural	12	2,462	15	1,970	1
2	20	Energy Conservation	6	2,444	18	815	3
3	19	Mechanical	19	2,069	20	1,965	2
4	02	Pavements	11	1,362	20	749	4
5	15 16	Electrical, Electronic	8	800	15	427	9
6	01 03	Paints, Waterproofing	48	729	63	555	5
7	07	Corrosion	9	633	11	517	6
8	10,11	Disposal	14	611	17	503	7
9	04,05	Pollution	10	569	13	438	8
10	06 09 12	Concrete, Materials & Plastics	9	154	17	82	10
11	18	Roofs	7	126	16	55	11
			153*		225**		

* 18 Cases were omitted in the grouping process; 82 Benefit Code 17 cases and 40 not-counted cases are not included. (Total: 293 cases)

** 28 Cases were omitted in the grouping process; 40 not-counted cases are not included. (Total: 293 cases)

lists are Project Description Codes 17 (Structural), 20 (Energy Conservation) and 19 (Mechanical). This is followed by a group of mid-range project types. Lastly, the lowest ranking codes by all three methods are 06 (Concrete), 09 (Materials), 12 (Plastics) and 18 (Roofs).

2. Correlation of Benefits by Originator Type

Table VI shows the breakdown of benefits by the six originator codes utilized in the FY '74 analysis. Again, the average benefit per request figure is shown both with and without inclusion of the Benefit Code 17 cases. Except for the reversal of "Shops" and "Housing," the inclusion of the Code 17 cases does not affect the ranking. The small number of requests in both the "Shops" and "Housing" categories makes the figures for these two categories unreliable. Both categories had one large project ($10,000 of the $10,529 total in the "Shops" category and $7,000 of the $7,500 total in the "Housing" category) which dominates that category. Cases in which the questionnaire stated that the EFD RDT&E liaison representative was the originator of the request, the "Other" category was used. Approximately 50% of the 49 requests under this category were originated by the RDT&E representatives. The average benefit per request under the "Other" category is somewhat indicative, therefore, of the value of the RDT&E representatives as a request originator. The following relative ranking results:

1. Military-CEC ..... $1,358 per request
2. Engineering ..... 1,034 " "
3. Other ..... 636 " "
4. Maintenance ..... 346 " "

Housing and Shops are left unranked.

TABLE VI

VALUE OF BENEFITS BY ORIGINATOR

Description	Value of Benefits	Benefit Code #17 Omitted: No. of Requests	Benefit Code #17 Omitted: Benefit Per Call	Benefit Code #17 Included: No. of Requests	Benefit Code #17 Included: Benefit Per Call
Military--CEC	$44,818	33	$1,358	51	$878
Maintenance	6,219	18	346	35	178
Engineering	81,694	79	1,034	108	756
Housing	7,550	4	1,888	5	1,510
Shops	10,529	4	2,632	5	2,106
Other	20,991	33	636	49	428
	$171,800	171*		253**	

* 82 Benefit Code 17 cases are not included. (Total: 293 cases)

** 40 Not-counted cases are not included. (Total: 293 cases)

3. Correlation of Benefits by Activity Type

Table VII shows the breakdown by activity type. Again, use of Benefit Code 17 cases does not affect the relative ranking. The last three types (OICC/ROICC, Staff/CEC and Other) are eliminated due to the small numbers of requests and/or dominance by a single request. The resulting ranking of remaining types is as follows:

1. PWC ..... $1,756 per request
2. EFD ..... 860 " "
3. PWO ..... 444 " "

TABLE VII

VALUE OF BENEFIT BY ACTIVITY

Description	Value of Benefits	Benefit Code #17 Omitted: No. of Requests	Benefit Code #17 Omitted: Benefit Per Call	Benefit Code #17 Included: No. of Requests	Benefit Code #17 Included: Benefit Per Call
PWD	$54,558	80	$682	123	$444
EFD	77,364	64	1,209	90	860
PWC	28,089	12	2,341	16	1,756
OICC/ROICC	5,510	6	918	10	551
Staff/CEC	575	3	192	5	115
Other	5,704	6	951	9	634
	$171,800	171		253	

TABLE VIII

VALUE OF BENEFIT BY EFD

EFD Area	Value of Benefits	Benefit Code #17 Omitted: No. of Requests	Benefit Code #17 Omitted: Benefit Per Call	Benefit Code #17 Included: No. of Requests	Benefit Code #17 Included: Benefit Per Call
Northern	$13,206	12	$1,106	19	$695
Southern	18,430	18	1,024	24	767
Chesapeake	411	5	82	18	23
Pacific	38,002	19	2,000	21	1,810
Western	79,855	83	962	124	644
Atlantic	21,896	34	644	47	465
	$171,800	171		253	

4. Correlation of Benefits by EFD Area

Table VIII shows the breakdown by the areas covered by the six Engineering Field Divisions. Examination of the range of benefits for each area revealed the following notable facts: Northern Division's benefits totaling $13,206 included one case with a benefit of $12,000; Pacific Division's benefits totaling $38,002 contained two large benefit cases totaling $21,249. With the exception of Chesapeake Division, the facilities within each EFD area are very similar. For this reason, ranking of the EFD areas for purposes of identifying profitable areas in which to concentrate effort is inappropriate.

B. UTILIZATION OF FESO WITHIN THE SHORE ESTABLISHMENT

One factor to consider in evaluating the present effectiveness of FESO, and to measure its growth potential, is to examine its existing market. Table IX displays the distribution of assistance requests for FY '74 by activity type and geographical location. In analyzing the data presented on the table, several factors appear significant. Each EFD and PWC is using the FESO service at least once; however, of the 182 separate PWD's, only 61 are using the service. In the OICC/ROICC area, only ten of 73 units are responding. This low utilization by the OICC/ROICC may be expected in that the predominant organization in this category would be the ROICC office. The ROICC's responsibility is to enforce the plans and specifications provided. This type of function is not

TABLE IX

DISTRIBUTION OF FY '74 ASSISTANCE REQUESTS*

ACTIVITY TYPE

EFD Areas	PWD's			EFD's			PWC's			OICC/ROICC		
	Total Units **	Units Calling	Total Calls	Total Units **	Units Calling	Total Calls	Total Units **	Units Calling	Total Calls	Total Units **	Units Calling	Total Calls
Northern	33	5	13	1	1	4	2	2	4	12	1	2
Southern	30	9	12	1	1	15	1	1	1	15	2	2
Chesapeake	15	4	4	1	1	15	0	0	0	14	0	0
Pacific	16	3	7	1	1	12	4	4	8	8	0	0
Atlantic	47	11	14	1	1	32	1	1	2	13	2	2
Western	41	29	106	1	1	27	1	1	7	22	5	6
TOTAL	182	61	156	6	6	105	9	9	22	83	10	12

Total units = 280; total units calling = 86; total calls = 295.

* Includes only PWC's, EFD's, PWD's and OICC/ROICC's.

** Approximated from CEC Directory (Spring 1974).

conducive to state-of-the-art innovations and requirements for technical assistance.

The void in providing assistance to the approximate 120 PWD's, on the other hand, would appear to offer room for improvement. WESTDIV is the only geographic area in which over 50% of the PWD's are utilizing the FESO. In fact, 70.7% of the activities in WESTDIV used the FESO in FY '74 compared to the next highest user, SOUTHDIV, with a 30% usage. Even with this high utilization, WESTDIV's benefit per call of $962 is relatively high (see Table VIII). This would indicate the payoff per call is not reduced significantly with increasing saturation of the market. It could be concluded that a goal of the FESO would be to increase the utilization of the PWD's by increasing their general awareness of the available services.

Although all of the PWC's did use the FESO service, the total number of calls was quite low. As indicated on Table VII, the benefit per call was $2,341, more than twice as high as the next lower category. The high benefit and low number of calls could be caused by the fact that each PWC has considerable staffing in the engineering and technical fields and could routinely handle problems of this nature without the assistance of CEL. Problems which are referred to CEL would, in general, be of a significant nature with a high chance of an appreciable benefit.

C. AN APPROACH TO OPTIMIZING THE FESO SYSTEM

In that the primary purpose of the FESO is to respond to a user's request, the key element leading to the effectiveness of the program is to insure that the field personnel are aware of the program and how to use it. To this end, the FESO publishes and distributes brochures and pamphlets describing current ongoing research projects being carried out by CEL and methods to obtain information concerning these projects. In addition, a FESO representative performs site visits, time permitting, to explain the program to various activities. The FY '74 questionnaire attempted to identify how individuals using the FESO service in FY '74 learned of the availability of the service. This data is presented in Table X.

In analyzing Table X, past experience is by far the predominant reason that a requestor knew of CEL. Past experience includes those who have previously used CEL for assistance or have been associated with the facility in some way in the past. Of the 295 requests, 60 were from Civil Engineer Corps officers who, as a part of basic orientation at the Civil Engineering Officers School (CECOS) at Port Hueneme, are briefed on CEL's availability. "Verbal-local" defines a requestor who learned of FESO from another individual within the same department or office. The high percentage of calls attributed to the EFD, RDT&E representatives is primarily due to his centralized location within the EFD and the fact that a significant part of his every-day job is devoted to RDT&E-related business. The "rap briefs," "Technical bulletins" and "other CEL

TABLE X

HOW REQUESTORS KNEW OF THE FESO SERVICE IN FY '74

Reasons	Number of Calls	Percentage of Total
Verbal-Local	47	15.9
Past Experience	93	31.5
CEL Site Visit	18	6.1
Rap Briefs	18	6.1
Technical Bulletins	9	3.1
Other CEL Publications	16	5.4
EFD, RDT&E Representatives	45	15.3
Other	13	4.4
Information Not Available	36	12.2
TOTAL	295	100%

publications" may have considerable overlap since many individuals interviewed were not sure in exactly which publication they learned of the FESO. For that reason, the combined percentage of 14.6% may provide a more meaningful representation. This category represents, along with "site visits," the primary means that FESO can directly effect utilization of the program by using activities. In that the CECOS is located in close proximity to the CEL and offers numerous programs that are attended by both civilian and military representatives of the shore activities, advertising the FESO program through this media could also prove beneficial.

The method of optimizing the FESO system within the resources available should necessarily develop from an interrelationship of the various parameters discussed in this chapter. The FESO resources available for advertising the program via site visits, brochures, etc. should be directed to geographical locations, originator types and activity types that appear to provide the highest payoff as well as offering an unsaturated market. In addition, availability of assistance in the project types which appear to yield the greatest payoff should be stressed.

IX. SUMMARY AND CONCLUSIONS

General:

1. The study demonstrated that it is possible to meaningfully quantify in dollars a significant portion of the benefits of a technology transfer system.

2. The model derived to measure benefits and display the subjectivity, although not subject to analytical test and proof, has been used and the results obtained therefrom have intuitive appeal.

3. A method has been proposed to extrapolate from the quantifiable portion of the benefits of the system obtained by the model to a figure or range of figures that approximate the benefits of the total system.

Specific:

1. The Facilities Engineering Support Office was profitable to the Navy's shore establishment during FY '74. Benefits quantified in this study exceeded the given cost in excess of 2 to 1.

2. There was a distinguishable variation of profitability within project types, geographical location, originator and type of activity which, if exploited in conjunction with market availability, should return optimal payback for the limited advertising resources available.

3. A significant number of projects considered beneficial by the users were also believed to have possible application

at other shore facilities. Direct communication of information on proven beneficial projects to other possible users could compound the positive returns of the program.

4. The number of requests received from the shore facilities over the past three fiscal years has increased. Examination of the potential users not presently utilizing the program indicates there is a potential for expansion.

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APPENDIX A

FESO FY '74 RDT&E ASSISTANCE EXPENDITURES*

Short-Term Requests: (Less than 20 man-hours)		
Submitted by PWC's, EFD's, PWD's and OICC/ROICC's (273 in total)	$48,841	
Submitted by all other activities	17,762	
		$66,603
Job Order Requests: (Greater than 20 man-hours or $500)		
All requests submitted prior to FY '74 ...	56,275	
Submitted by PWC's, PWD's, EFD's and OICC/ROICC's during FY '74 (22 in total)	66,346	
Submitted by all other activities during FY '74	42,052	
		164,673
Administrative:		
Includes salary of one civilian and miscellaneous expenses		41,494
TOTAL		$272,770

* Basic figures provided by CEL, and include overhead burden.

APPENDIX B

FY '72 FESO PROJECT EFFECTIVENESS (QUESTIONNAIRE)

1. Date of initial contact (month)_____

2. Brief description of request or problem_____

3. Who initiated the communication?_____

4. What area of advice or assistance was involved?

   1. Paints-coatings-Chem.
   2. Concrete
   3. Corrosion
   4. Pollution
   5. Pavements
   6. Pavement condition data
   7. Piles-camels
   8. Roofs
   9. Other_____

5. What was the means of initial contact with NCEL/RDT&E?

   1. Phone
   2. Letter
   3. Message
   4. Personal contact
   5. No follow-up
   6. Other_____

6. What method of follow-up was used?

   1. Phone
   2. Letter
   3. Message
   4. Personal contact
   5. No follow-up
   6. Other_____

7. Describe the degree of utilization of the advice and/or assistance.

   1. Directly implemented
   2. Test and/or evaluation established as a result of contact.
   3. Problem solved without utilization of advice/assistance.
   4. Contact caused further inquiries which led to solution.
   5. Advice was not applicable to particular problem and no benefit resulted.

8. What was the level of contact with NCEL?

   1. NAVFAC
   2. FED
   3. PWO
   4. PWC
   5. OICC
   6. ROICC
   7. CBC
   8. Seabee unit
   9. Other

9. Was the information used? Yes_____ No_____

   If yes, answer questions 10, 11 & 12. If no, answer question 13.

10. If NCEL/RDT&E advice had not been available and existing methods had been continued, what do you estimate the cost would have been in terms of dollars, time, or inconvenience over a 5-year period?

DOLLARS	MAN HOURS	INCONVENIENCE
1. Under-500	1. Under-50	1. Costly delay
2. 500-999	2. 50-99	2. Inconvenient delay
3. 1000-4999	3. 100-199	3. Inconvenience to personnel
4. 5000-15000	4. 200-500	4. No inconvenience
5. Other_____	5. Other_____	5. Other_____
		6. Fleet operations affected

11. If NCEL/RDT&E advice, assistance or influence was received, estimate the costs over a five-year period.

DOLLARS	MAN HOURS	INCONVENIENCE
1. Under-500	1. Under-50	1. More inconvenience than older method
2. 500-999	2. 50-99	2. Places continuing burden
3. 1000-4999	3. 100-199	3. Requires highly skilled personnel
4. 5000-15000	4. 200-500	4. Other_____
5. Other_____	5. Other_____	

12. If NCEL/RDT&E advice, assistance or influence was received, estimate the intangible benefits derived. Circle one or more.

1. Technology used on more than one project.
2. Significant dollar savings resulted.
3. Provided stimulus for subsequent solutions to other problems.
4. Reduced subsequent severity of problem.
5. Resulted in lowering of skill level of personnel required to accomplish a task.
6. Resulted in further research or testing.
7. No benefit derived.
8. Reduced time to do job.
9. Increased life or maintenance interval.
10. Other benefit_____

13. If advice was not used, circle one or more.

1. Did not agree with advice.
2. Advice did not apply to problem.
3. Solution too expensive.
4. Expect to use in future.
5. Insufficient information was provided.
6. Other_____

APPENDIX C

FY '73 FESO PROJECT EFFECTIVENESS PROFILE (QUESTIONNAIRE)

1. Date of initial contact (Month)/ 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 / 11 / 12/ (circle one only)

2. Brief description of the Project: _____

3. This project was initiated by a: (Check only one)

   1. Civilian engineer
   2. Civilian scientist
   3. Civilian, other
   4. Military engineer
   5. Military scientist
   6. Military, other

4. What area of advice or assistance was involved? (check only one)

   1. Paint, coatings, chem.
   2. Pavements
   3. Water proofing
   4. Water pollution
   5. Misc. pollution
   6. Concrete
   7. Corrosion
   8. Piles & camels
   9. Building materials
   10. Classified disposal
   11. Unclassified disposal
   12. Plastics & resins
   13. Explosive damage
   14. Seismic effects
   15. Electrical
   16. Electronic
   17. Structural
   18. Roofs
   19. Mechanical
   20. Other: _____

5. What was the means of initial contact with NCEL/RDT&E? (check only one)

   1. Phone
   2. Letter
   3. Message
   4. Personal contact
   5. Other: _____

6. What method of follow-up was used? (check only one)

   1. Phone
   2. Letter
   3. Message
   4. Personal contact
   5. Phone & Letter
   6. Phone & message
   7. Phone & personal contact
   8. Letter & personal contact
   9. Other: _____

7. Describe the degree of utilization of the advice and/or assistance. (check only the one most appropriate)

   1. Directly implemented.
   2. Test and/or evaluation established as result of contact
   3. Problem solved without utilization of advice and/or assistance.
   4. Contact indicated more extensive research was necessary.
   5. Advice was not applicable to the particular problem.
   6. Advice was not applicable to the particular problem but was useful for a different problem.
   7. No advice and/or assistance was received.

8. If NCEL/RDT&E advice and/or assistance had not been available and therefore the existing methods had been continued, what do you estimate the total operating cost would have been in terms of dollars over the next five-year period? (check only one)

    1. Under $500
    2. $500 to $999
    3. $1,000 to $4,999
    4. $5,000 to $15,000
    5. More than $15,000

9. If NCEL/RDT&E advice and/or assistance or influence was received, estimate the new total operating cost over a five-year period. (check only one)

    1. Under $500
    2. $500 to $999
    3. $1,000 to $4,999
    4. $5,000 to $15,000
    5. More than $15,000

10. Many improvement projects have intangible benefits or inconveniences that are independent of measurable dollar benefits. If NCEL/RDT&E advice and/or assistance was utilized, then estimate the intengible effects. (check as many as are appropriate)

    1. The technology was used on more than one project.
    2. The advice and/or assistance provided stimulus for subsequent solutions to other projects.
    3. Reduced the subsequent severity of the problem.
    4. Resulted in lowering of skill level of personnel required to accomplish a task.
    5. Resulted in requests for further research or testing.
    6. More inconvenient than older method.
    7. Requires higher skilled personnel than older method.
    8. Operating dollar savings were only benefit derived.
    9. Other benefits: _____

If for any reason you did not answer each of the above questions, that is, questions No. 6, No. 7, No. 8, No. 9 and No. 10, then please explain.

APPENDIX D

TOTAL REQUESTS BY ACTIVITY

Activity	FY '72	FY '73	FY '74
Engineering Field Divisions (EFD's)	85	104	105
Public Works Departments (PWD's)	97	123	156
Public Works Centers (PWC's)	23	29	22
Construction, OICC/ROICC	7	26	12
Naval Facilities Engineering Command (NAVFAC)	18	21	33
Chief Naval Material (CNM)	1	2	3
Civil Engineering Support Office (CESO)	13	8	8
Construction Battalions and Other Seabee Units (ACB's, MCB's, UCT's, NCR's, CBC's)	15	19	28
Other: Non-NAVFAC	22	17	29
TOTAL	281	349	396

APPENDIX E

PER CENT OF TOTAL REQUESTS BY PROJECT TYPE

Project Type	FY '72	FY '73	FY '74
Paint, Coatings, Chemicals	25.3	18.3	23.7
Pavements	4.8	4.3	7.5
Waterproofing	0.0	0.0	2.4
Water Pollution	7.2	9.7	4.1
Miscellaneous Pollution	7.2	3.2	1.0
Concrete	10.8	5.4	3.7
Corrosion	12.0	5.4	4.4
Piles and Camels	2.4	0.0	2.4
Building Materials	3.6	2.2	2.0
Classified Disposal	1.2	6.5	3.1
Unclassified Disposal	2.4	2.2	4.4
Plastics and Resins	0.0	1.1	1.0
Explosive Damage	1.2	2.2	1.0
Seismic Effects	2.4	0.0	0.7
Electrical	6.0	3.2	4.7
Electronic	0.0	5.4	0.7
Structural	1.3	6.5	5.4
Roofing	2.4	2.2	5.8
Mechanical	6.0	4.3	8.1
Energy Conservation	*	*	7.8
Other	3.6	18.3	5.1
TOTAL	100%	100%	100%

* Project type not used.

APPENDIX F

FY '74 FESO PROJECT EFFECTIVENESS QUESTIONNAIRE

Block Number

1. Description of project: _____ — 1

2. Do you consider that the advice/assistance received was in any way beneficial? (If CEL contact led to another source of useful information, check yes and include that source in answering questions 4 through 7.) — 2

_____ (1) Yes _____ (2) No — 3

3. If no, why not? (Upon completion of this question, skip questions 4 through 7.) (check one) — 4

_____ (1) no reply received.
_____ (2) lab could not provide expertise in this area. — 5
_____ (3) other. Please explain: _____ . — 6

4. Describe the degree of utilization of the advice and/or assistance. (check as many as are appropriate) — 7

— 8

— 9

_____ (1) directly implemented. — 10
_____ (2) direct implementation is planned. — 11
_____ (3) test and evaluation of recommended solution is planned or underway. — 12
_____ (4) more extensive research on proposed solution is planned or underway. — 13
_____ (5) advice was not applicable to particular problem but useful on others. — 14
_____ (6) problem solved without utilization of advice/assistance. — 15

— 16

— 17

5. If implementation of advice/assistance has been accomplished or is planned, estimate the savings. (answer as many as are appropriate) — 18

— 19

(1) Savings in one time repair or construction cost. $_____ — 20

— 21

(2) Savings in maintenance cost. $_____ per _____. (time period) — 22

— 23

(3) Savings in operating cost. $_____ per _____. (time period) — 24

(4) Other. Explain: _____ — 25

— 26

6. Do you feel the solution to the problem could be applicable to other activities? (check one) — 27

— 28

_____ (1) Yes _____ (2) No — 29

— 30

— 31

7. Many improvement projects have intangible benefits that are independent of measurable dollar benefits. If CEL/RDT&E advice and/or assistance was utilized, then estimate the intangible effects. (check as many as are appropriate)

Block Number

__ 32
__ 33
__ 34
__ 35
__ 36
__ 37
__ 38
__ 39

_____ (1) The technology was used on more than one project.
_____ (2) The advice and/or assistance provided stimulus for subsequent solutions to other projects.
_____ (3) Reduced the subsequent severity of the problem.
_____ (4) Increased safety factor.
_____ (5) Increased morale.
_____ (6) Increased education/training of personnel.
_____ (7) Dollar savings were only benefit derived.
_____ (8) Other intangible benefits: _____
_____

__ 40
__ 41

__ 42
__ 43
__ 44
__ 45

8. Where did you learn of the availability of Civil Engineering Lab's FESO Program for assistance on field problems?

_____

__ 46
__ 47
__ 48
__ 49

Name of person originating request:_____

Activity_____ Position_____ Autovon No. _____

__ 50
__ 51
__ 52
__ 53

Name of person filling out questionnaire (if different than originator):_____

Activity_____ Position_____ Autovon No._____

Project number:_____

APPENDIX G

CODING SHEET

Project Description Type

Block 1-2
(VAR001)

01 - Paint, Coatings, Chemical
02 - Pavements
03 - Waterproofing
04 - Water Pollution
05 - Miscellaneous Pollution
06 - Concrete
07 - Corrosion
08 - Piles and Camels
09 - Building Material
10 - Classified Disposal
11 - Unclassified Disposal
12 - Plastics and Resins
13 - Explosive Damage
14 - Seismic Effects
15 - Electrical
16 - Electronic
17 - Structural
18 - Roofs
19 - Mechanical
20 - Energy Conservation
21 - Moorings
22 - Other

Block 3
(VAR002) Any Benefit?

1 - Yes
2 - No

Block 4
(VAR003) If No Benefit

1 - No reply received from Lab.
2 - Lab had no expertise.
3 - Lab requested additional information.
4 - No information available on request.
5 - No benefit (duplicated request).
6 - Other

Block 5-6
(VAR004) Benefit Codes

01 - Action recommended, implemented, estimable
02 - Information provided, implemented, estimable
03 - Action recommended, implemented, not estimable

Block 5-6
(VAR004)

04 - Action recommended, planned, estimable
05 - Information provided, implemented, not estimable
06 - Information provided, planned, estimable
07 - Action recommended, test, estimable
08 - Information provided, test, estimable
09 - Action recommended, eval., estimable
10 - Information provided, eval., estimable
11 - Action recommended, planned, not estimable
12 - Information provided, planned, not estimable
13 - Action recommended, test, not estimable
14 - Information provided, test, not estimable
15 - Action recommended, eval., not estimable
16 - Information provided, eval., not estimable
17 - Information filed, no action

Block 7-12
(VAR005) Savings in One-Time Repair/Construction Cost

Block 13-18
(VAR006) Savings in Annual Maintenance Cost

Block 19-24
(VAR007) Savings in Annual Operating Cost

Block 25-30
(VAR008) Magnitude of Project

Block 31
(VAR009) Solution Applicable to Others

1 - Yes
2 - No

Block 32-39
(VAR010 to VAR017) Intangible

Block 40-41
(VAR018) How Did Requestor Learn of Lab?

01 - Word of mouth (local)
02 - Past experience
03 - Site visit by CEL personnel
04 - RAP briefs
05 - Technical bulletins
06 - Other CEL publications
07 - EFD RDT&E representative
08 - Other
09 - Information not available

Block 42
(VAR-19) District Questionnaire

1 - Yes
2 - No

Block 43
(VAR020) EFD Area

1 - Northdiv
2 - Southdiv
3 - Chesdiv
4 - Pacdiv
5 - Westdiv
6 - Lantdiv

Block 44
(VAR021) Originator Type

1 - Military CEC
2 - Maintenance
3 - Engineering
4 - Housing
5 - Shops
6 - Other

Block 45
(VAR022) Activity Type

1 - PWD
2 - EFD
3 - PWC
4 - ROICC/OICC
5 - CBC/Seabee Unit
6 - NAVFAC
7 - Staff Civil Engineer
8 - Other

Block 46-47 Information-%-Factor

1-99

Block 48 Additional Information

5 - Advice not applicable to particular problem but useful on others.
6 - Problem solved without utilization of advice or assistance.

Block 49 Blank

Block 50-53 Project Number

APPENDIX H

NUMBER OF FY '74 SHORT-TERM ASSISTANCE REQUESTS BY PROJECT TYPE AND CEL DIVISION*

Project Type	CEL Divisions**												
	42	43	51	52	53	55	61	62	63	64	65	L-03C	Total
Pavements.....				7	13				1				21
Paints, Water-proofing.....				69			1				2		72
Pollution.....				3							11		14
Corrosion.....		1		10						1			12
Building Materials, Concrete.....				18									18
Disposal.....					1				10		7		18
Electrical.....				6				10					16
Structural.....			2	5	5	2					2		16
Roofs.....				16									16
Mechanical.....				5	1			1	2	3	6		18
Energy Conser-vation.....		1		2				1	14		1		19
Other.....	1	1	3	6	2	5	1			2	3	9	33
TOTAL...	1	3	5	147	22	7	2	12	27	6	32	9	273
Division Cost Per Request***	380	173	310	172	241	115	341	157	95	189	273	---	---

* Includes only requests from PWC's, PWD's, EFD's and OICC/ROICC's.

** See CEL organization chart for further details.

*** Provided by CEL--average of all requests in each division.

APPENDIX I

BENEFIT VALUES OF SHORT-TERM REQUESTS BY PROJECT TYPE*

Project Type	Number of Requests	Benefit Value	Benefit Per Request
Paint, Coatings, Chemicals	43	$27,598	$642
Pavements	10	10,481	1,048
Waterproofing	3	3,598	1,199
Water Pollution	8	5,487	686
Miscellaneous Pollution	1	50	50
Concrete	3	176	59
Corrosion	8	5,380	673
Piles and Camels	4	925	231
Building Materials	4	160	40
Classified Disposal	5	6,224	1,245
Unclassified Disposal	7	1,200	171
Plastics and Resins	1	300	300
Explosive Damage	2	1,800	900
Seismic Efforts	0	0	0
Electrical	8	6,401	800
Electronic	0	0	0
Structural	12	29,545	2,462
Roofs	7	883	126
Mechanical	15	26,015	1,734
Energy Conservation	7	52,443	8,741
Mooring	2	1,110	555
Other	8	4,668	584
TOTAL	158**	$184,444	

* Includes only requests from PWD's, PWC's, EFD's and OICC/ROICC's.

** 158 + 22 job orders + 78 Category 17's + 37 no-counts = 295 total requests.

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